Vol. 45 APRIL, 1952 No. 4

NATIONAL FIRE PROTECTION ASSOCIATION

Quarterly

Published Quarterly at Boston, Mass., by the
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International

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Volume 45 April 1952 Number 4

Quarterly

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of the

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International

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The National Fire Protection Association is a non-profit technical and educational organization devoted to the reduction of loss of life and property by fire with more than 14,000 members. The *Quarterly* is one of the publications regularly provided to members. Other membership publications include a monthly *Fire News, Advance Reports* and *Proceedings* of the Annual Meetings, a *Year Book*, and many leaflets, pamphlets and posters issued throughout the year on fire prevention and control.

Technical committees of the Association develop means to safeguard life and property through the publication of standards covering all phases of fire prevention and protection. Your membership in the Association (annual dues $12.50) affords an opportunity to keep abreast of these developments and, by being a member, you help support this humanitarian activity. Popular educational literature on fire safety is constantly being produced by the NFPA for distribution through its members to the general public.

All members of the Association and the public are invited to NFPA meetings. The following dates are now on the Calendar:

NFPA Calendar

1952	
June 9-13	Annual Meeting, Hotel Statler, N. Y.
Dec. 1-3	Regional Meeting, Houston, Tex.
1953	
May 11-15	Annual meeting, Palmer House, Chicago.

The closing date for articles submitted for the *Quarterly* is the 15th of the month preceding publication.

Quarterly

of the

NATIONAL FIRE PROTECTION ASSOCIATION

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Accounts of fires appearing in the Quarterly are copies of or extracts from reports forwarded to the Association except where otherwise indicated. The Association, as a body, is not responsible for the statements or opinions of any of its members. This publication is indexed by Engineering Index, Inc.

Acme

Although located in the large American city of Indianapolis, the clothing store in this building had no interior stairways between the third and fourth stories. Since the elevator could not be used and smoke and flames reportedly made the outside fire escape impassable, it was only due to the efficient efforts of the fire department using ladders that the eight employees in the alterations department were rescued from fourth story windows.

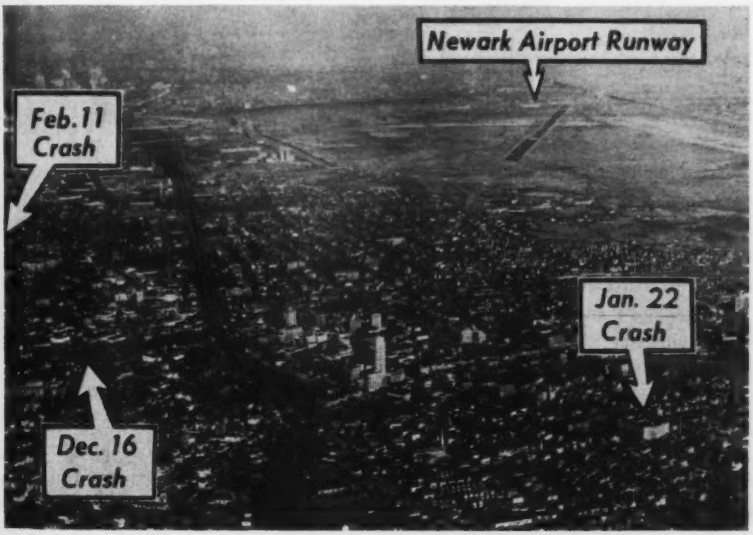
The story of the fire itself has been told many times — basement origin, no sprinkler protection, unprotected vertical openings, false store front, concealed ceiling spaces. The owners of the store had taken the precaution to install a central station supervised automatic fire detection system but had neglected to take certain other steps necessary to protect life, limit fire spread and to assure prompt extinguishment.

Elizabeth, N. J. — Incredible Coincidence!

The laws of probability, according to one aviation safety engineer, would have ruled out what happened in Elizabeth except once in 36,000,000 years! The Elizabeth Fire Department only knows that in two months they had to fight three aircraft crash fires in an area a mile and a half long and a quarter of a mile wide. These three accidents caused 119 deaths and at least 51 were injured. Eleven of those killed were residents of the buildings struck. Property and aircraft losses and presently known life insurance claims indicate an aggregate monetary loss of about $3,500,000.

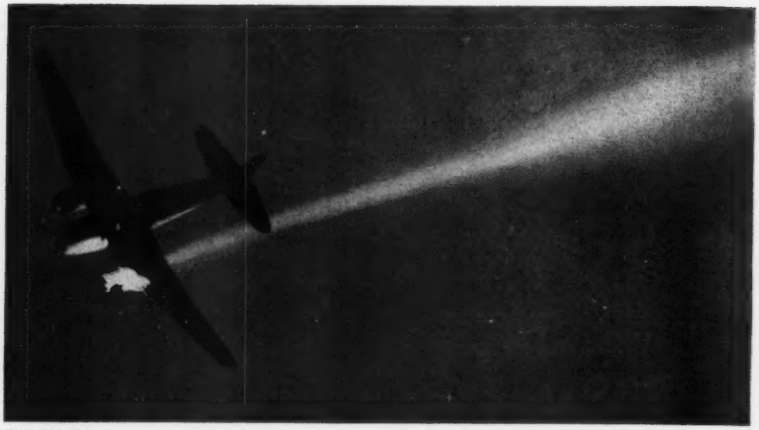
This report based on information supplied by Mr. Robert R. Kalkman (Continental Insurance Co.) and Deputy Chief Edward F. Deignan, Elizabeth Fire Department.

Particularly notable about the accidents was that the only common denominator linking the three was that each of the aircraft involved was attempting to enter or keep within the traffic pattern of the same runway at Newark Airport. Two had just taken off and, because of in-flight difficulties, were seeking to return for emergency landings. The third was attempting a normal instrument approach when it suddenly went out of control and crashed. As a result of these three accidents, Newark Airport was closed by the operator, the Port of New York Authority, until a full investigation could be made. At this writing, the Airport is still closed except "for limited use by the U. S. Air Force."



Associated Press Newsphoto

No. 1, 2 and 3 Crashes. Air view of Elizabeth showing Newark Airport in the background. For 23 years aircraft operated from this airport without an accident in Elizabeth until these three occurred within two months. The Jan. 22 accident was 1½ miles from the site of the Feb. 11 crash.



"The News"

No. 1 Crash. Investigation revealed that this in-flight fire of a C-46 which crashed in Elizabeth, N. J. on Dec. 16 was caused by failure from fatigue of No. 10 cylinder's hold-down studs due to improper installation of their nuts. No engine fire extinguishing system was provided and the engine fire caused wing structural failure which caused the uncontrolled crash and death to 56.

Other cities also sustained "within-limits" crashes during the year—Chicago, Seattle, and Denver to mention only the most outstanding examples. In each of these situations, as in Elizabeth, the proximity of airport facilities to the built-up area were factors in the accidents. Not always have airports been located where they expose *existing* densely populated areas; in some notable cases, airports have attracted extensive housing and industrial developments to their environs on previously undeveloped land, particularly those airports which boast aircraft production or maintenance facilities within their confines. These zones might well be considered "accident-prone" under certain conditions (depending on flight patterns) but no city is immune to certain kinds of aircraft accidents where descent is uncontrolled. Small towns like Morningside, Maryland, and Temple City, California, had crashes during 1951 quite unrelated to airport proximity. But, it was Elizabeth, N. J., which has brought the matter into focus.

No. 1 Elizabeth Fire

The first accident occurred at 3:09 P.M., Dec. 16, when a twin-engine C-46, operated by Miami Airlines, crashed soon after takeoff, following an uncontrolled engine fire in flight which, subsequently, caused wing structural failure. This was an uncontrolled descent. Weather was good and not a factor. All 56 occupants of the aircraft were killed.

Fire Alarm for No. 1

Before the first crash, a Captain of Engine Co. No. 7 of the Elizabeth Fire Department noted the burning C-46 in flight and his Company responded when it was apparent that the aircraft would crash close to quarters. Four street alarm boxes were pulled by citizens in rapid succession and automatic multiple box alarm response

brought 10 companies and 80 men from the Elizabeth Fire Department. Some 10 to 15 minutes after the crash a Port of New York Authority crash truck from Newark Airport reached the scene, almost 2 air miles from the airport.

Crash Impact Conditions

The C-46 was out-of-control when it began its sharp descent, a wing having failed in flight. The aircraft struck a corner of an unoccupied frame building, demolished a 2-story brick storehouse, overturned and landed on its back in two feet of water near the east bank of the Elizabeth River. (See Figure 1.)

Fire and Rescue Problems

Even when the first companies arrived at the site of the first crash, fire heavily involved the partly submerged C-46 as it

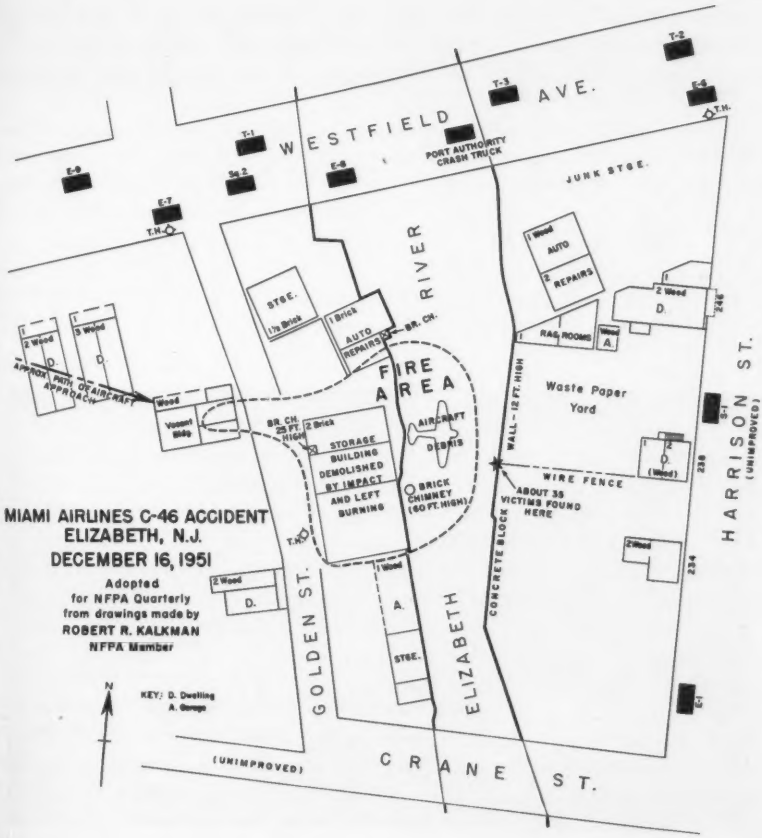


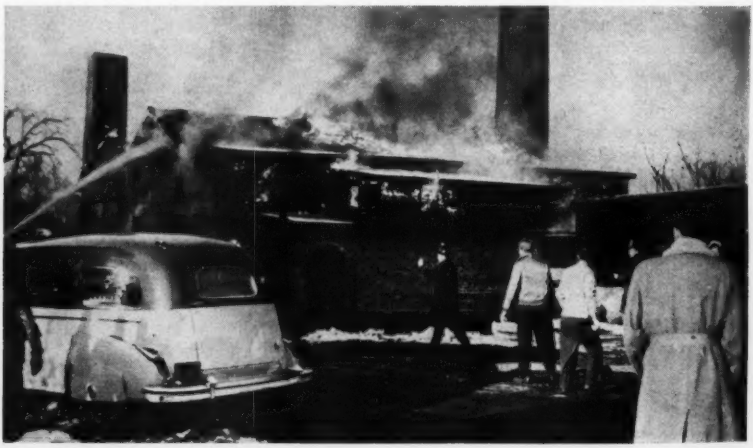
Figure 1 — Crash No. 1. The black rectangles represent fire equipment positioned around the accident site.

rested in the shallow waters of the Elizabeth River. The two-story brick warehouse was badly wrecked and was also heavily involved in fire. It was quickly evident that all the occupants of the aircraft had been killed by the impact. Thirty-five of the 56 had been catapulted from the aircraft and were found in one mass on the east bank of the river. Two 30-foot ladders were lashed together, truss side up, and planks were placed over the rungs to serve as a bridge for litter bearers to transport the bodies from the east bank to waiting morgue vehicles. No victims were found in the aircraft after the fuselage was raised and overturned. Despite the pre-crash response of Engine Company 7, and immediate box alarms, rescue opportunities were not present.

No. 1 Fire Fighting

At the first accident, because of the fear of floating unburned gasoline on the River, the Elizabeth Fire Department did not use foam on the aircraft and the waterborne gasoline spill fire. Hose streams were used to subdue the intense convective and radiated heat. Fog-foam and foam was used by the Port of New York Authority crash truck.

Several 2½-inch hose lines were stretched from Westfield Avenue to both sides of the River. Lines on the east side were used to wet down buildings seriously exposed to the radiated heat. Lines on the west bank were principally used on the burning brick storehouse. Two lines from a hydrant on Golden Street prevented fire spread to the frame garages communicating to the south. While the fires were practically extinguished within 60 minutes it took nearly 12 hours to remove all the victims. Fire Department services terminated at 3:30 A.M., 12 hours after the accident. This accident, unlike the other two, did not cause loss of life to anyone on the ground as the buildings struck were unoccupied.



Acme Photo

No. 1 Crash. The C-46 crashed into this storehouse (a former Pumping Station) causing a severe fire and its almost total destruction. The fuselage main section came to rest a few feet beyond on the edge of the Elizabeth River.

Figure 2 — Crash No. 2. The black rectangles represent fire equipment positioned around the accident site.

The second accident occurred at 3:44 P.M. Jan. 22 as an American Airlines "Convair" was making an instrument landing approach to Newark Airport. All 23 occupants of the aircraft and 7 on the ground were killed. The exact cause of this accident has not been officially revealed. Failure of a vital control surface might have been responsible as the change in the aircraft's attitude was sudden, the descent sharp and the pilot had no time to radio any difficulty. Weather was unfavorable; when the accident occurred there was a 400 ft. ceiling, intermittent rain, 1½ mile visibility, and a 14 MPH wind.

Answering a succession of box alarms, 10 pieces of Elizabeth apparatus and 160 men responded to the Convair accident site. A "recall signal" brought Chief Officers to the scene and again the Port Authority dispatched its crash truck. Roselle Park Fire Department also saw action in this second accident.

No. 2 Crash Impact Conditions

It is assumed that the Convair was also out of control when it struck three dwellings, completely demolished one, and damaged beyond repair a three-story brick building housing a store. (See Figure 2.)

International News Photo

No. 2 Crash. The aircraft must have been in a rather steep descent attitude to avoid a wider path of destruction. The Elizabeth Fire Department did a remarkable job of protecting exposed wood dwellings on the perimeter of the fire area.

Telephone wires surrounding the crash site along the streets were not knocked down.

No. 2 Fire and Rescue Problems

Fire companies responding to the second accident found the remains of the aircraft and the 2½-story wood dwelling burning fiercely. Another dwelling (a concrete block structure to the rear of the initial dwelling struck) and the three-story brick store were enveloped in smoke and flames as the result of a volume of gasoline that had penetrated the buildings following the impact. The 2½-story frame duplex dwelling at 312-314 Williamson Street was burning rapidly in the attic corner which was also struck by the aircraft.

It again appears that all 23 occupants of the aircraft were killed outright. Six occupants of the buildings struck were killed immediately and 1 died later in a local hospital. The fire department directed its first efforts to determining whether there was anyone alive in either the aircraft or the structures. Those occupants found dead were located in 306 and 310 Williamson Street.

Fire Fighting

Following the second crash, the task was to confine the fires to the involved structures after determining no rescues could be accomplished. These fires gained their initial rapid spread by being started with sprayed gasoline from the rupture of

the aircraft fuel tanks. The direction of the wind towards exposed dwellings prompted the use of a deluge set that was put in position opposite 310 Williamson Street. Hand lines were advanced after the fire had been subdued sufficiently in these two buildings.

Simultaneously, other fire crews attacked the fire in the crushed dwelling in which the bulk of the aircraft wreckage rested. The Port Authority crash truck used two foam lines on the burning aircraft, but most of the extinguishment was secured with 2½-in. hose lines (a total of 13 used). The effectiveness of the "stop" secured is made evident by the post-fire aerial photo which also shows how close the accident site was to two large schools which were fortunately missed. All fires were practically extinguished in 90 minutes, although mopping up and digging into the debris kept fire fighters at the scene until 1:30 A.M. when it appeared that all bodies had been recovered. (Two additional victims were found, however, on the following day.)

No. 3 Elizabeth Fire

Number three occurred Feb. 11 at 12:20 A.M. when a four-engine National Airlines DC-6 crashed soon after take-off following power failure of No. 4 engine and the unexplained reversal of the propeller of No. 3 engine.

This was the only accident of the three where some of the occupants of the aircraft survived. Twenty-six of the occupants were killed outright, 3 died later as a result of injuries and 37 escaped. Four residents of Elizabeth were fatally injured. It is probable that survival was made possible in this accident since the deceleration was in stages and a twenty-foot long aft

United Press-Acme Photo

No. 2 Crash. Close up of the main fire area shows how the brick store was gutted and the dwelling initially struck flattened. To the extreme right, it will be observed that this seriously exposed dwelling was protected from fire damage on the ground floor level. The attic floor to the rear was brushed by the aircraft and set afire but the Fire Department succeeded in preventing spread.

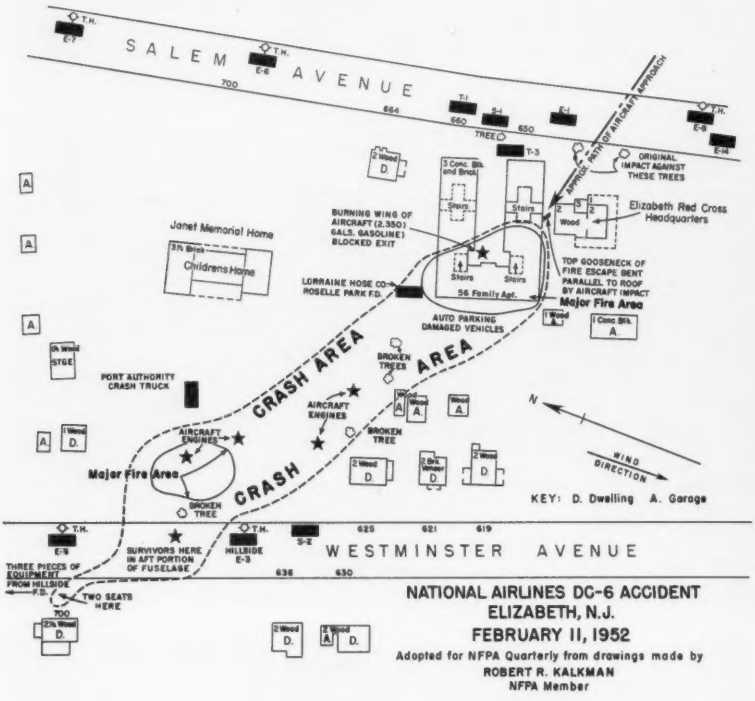


Figure 3 — Crash No. 3. The black rectangles represent fire equipment positioned around the accident site.

portion of the fuselage broke away from other parts of the aircraft and was not involved in fire.

Fire Alarm

A radio car of the Hillside Police Department was cruising about a block from the accident site of the February 11 crash and gave the first alarm, to the Hillside Fire Dept., for the third accident. (Hillside and Elizabeth have common borders within a block of the site.) The Elizabeth Fire Dept. was notified by a telephone alarm. Within 3 minutes, the complete first alarm companies were on the scene and a third alarm was sounded 6 minutes later. Elizabeth sent 10 companies and 145 officers and men; Hillside and Roselle Park responded with a total of 5 companies; the Port Authority again sent its crash truck.

Crash Impact Conditions

The DC-6 first came in contact with the top of two trees in front of the Elizabeth Red Cross Headquarters, knocked down an antenna on the top of this building, and then struck the roof gooseneck of one of the fire escapes on the south side of the 56-family apartment building at 650-660 Salem Avenue. A wing section dropped in the apartment courtyard when the air-

United Press Photo

No. 3 Crash. The path of destruction fortunately did not include the Janet Memorial Home (upper center). Figure 3 shows technical details of the crash area. Note how aircraft was diverted to miss other buildings as a result of the impacts.

craft struck and moved several inches the entire top story wall section at the northeast corner of the south stairway, skidded across the roof, demolishing an eight-inch cinder block, brick coped fire wall and tore down a section of the rear wall about five feet in depth and approximately eighty feet in length. This wall fell on automobiles parked in the rear of the building.

The impact with this building slowed the plane somewhat but in its further descent it snapped off several trees in the rear of the apartment, struck and skidded along the open ground behind the Janet Memorial Home, and, leaving engines and pieces of wing and tail behind, finally came to rest when a portion of the fuselage (about 20 ft. in length) uprooted a tree (three feet in diameter) and was inverted across the street from 700 Westminster Avenue. From Figure 3, it will be noted that apparently each object struck turned the aircraft slightly to the right and thus it passed dwellings it might well have otherwise demolished and this fact also probably saved the lives of those who survived the crash in the aft section of the fuselage.

No. 3 Fire and Rescue Problems

As firemen reached the scene of the third accident, a severe fire was in progress in the apartment house and its courtyard, involving building contents on the top floor, the cockloft and about 2,350 gallons of gasoline in the wing which fell into the yard. Other fires were in the open around the parts of wreckage as shown in Figure 3. Fortunately, the aft section of the fuselage, where survivors were found, was not involved in fire. Other, less fortunate, occupants of the DC-6, were found in an area of about 200 ft. by 850 ft., with

Associated Press Photo

No. 3 Crash. The unburned portion of the fuselage where the survivors were located. This section came to rest after breaking the trunk of a three-foot diameter tree. Those who escaped apparently had their seat belts attached.

indications that some had been catapulted as far as 650 ft. following the impact.

The burning wing cut off normal egress from one stairway in the apartment. One of the 4 victims who occupied the building was apparently trapped in a hallway and burned to death. The others were seemingly killed by the falling walls; their bodies were badly burned before they could be reached.

Occupants of the aircraft who survived reported that after the initial impact with the apartment building, flames entered the fuselage and inflicted serious burns on passengers even before the aircraft came to rest.

United Press Photo

No. 3 Crash. The burning apartment house which the DC-6 struck looks totally involved but actually only six apartments were severely damaged. The dropping of a wing in the apartment courtyard containing over 2,000 gallons of gasoline complicated fire fighting activity. Four occupants of the apartment lost their lives.

No. 3 Fire Fighting

Following the third crash, Elizabeth Fire Department personnel concentrated on the apartment building after size-up showed other fires were in the open and all survivors removed from hazardous areas. Hand lines were effectively used to prevent the spread of fire in the apartment to lower floors while an aerial was used as a water tower to knock down the bulk of the fire in the cockloft. An excellent "stop" was again made, only 6 apartments being severely damaged. Special attention had to be given to the burning wing section and the burning automobiles.

The Port Authority crash truck used fog foam on the outdoor major fire area involving aircraft parts. They were assisted by the Elizabeth Fire Department using foam and water fog. It is estimated that about 4700 gallons of gasoline from the aircraft's fuel tanks fed these fires. Some of the aircraft's fuel had been dumped intentionally by the pilot before the aircraft actually crashed. Residents 3 blocks away reported a gasoline "shower" but no fires occurred.

Fire fighting in various sections of the crash area continued for about four hours. Fourteen 2½-inch hose streams were used plus foam, fog-foam and turret streams. Again, the situation was favorable to the extent that the aircraft missed many dwellings it might have struck, but, most important, the Children's home.

Summary of the Three Crashes

Three accidents within two months in Elizabeth, N. J. did constitute an incredible coincidence! Each accident involved a different type of aircraft! Each accident involved airborne difficulties, each different in basic cause! Experienced pilots could not prevent disaster in any of the three!

While Elizabeth's proximity to Newark Airport can be cited as being the common denominator, these three accidents occurring in two months cannot be explained solely on this count against a background of over 23 years of operations at this airport which produced no such previous accident! While similar accidents might have occurred anywhere along the air routes, the fateful timing of the airborne difficulties were beyond human control at the time such difficulties occurred. These in-flight failures, coupled with the altitude of the aircraft involved combined to overcome pilot skills and aerodynamic lift.

The Elizabeth Fire Department and their cohorts did an admirable piece of work in each of the accidents. It was tragic that they did not have opportunity to perform rescue work, but this was through no lack of courage, determination or skill. The crash conditions simply made it impossible to save life in either of the first two accidents and, in the third, the survivors were either able to escape under their own power or were assisted by companions or local citizens.

The news of the disaster by press, radio, and television prompted the convergence of auto and pedestrian traffic to the scene, seriously interfering with the work of local police, fire, medical and Red Cross services. Well-meaning civil defense units from outside Elizabeth were among those who heard these flashes and rushed to the scene. Such disasters showed that as long as civil defense units are solely under municipal control, there is need for effective machinery to control intercity disaster work by civil defense personnel.

Not all aircraft accidents are like these three and local fire departments should not dismiss rescue operations, just because of

these occurrences. NFPA pamphlets 402* and 403* are recommended for study on this subject as well as NFPA Aviation Bulletin No. 80† giving tentative recommendations on "Aircraft Rescue and Fire-Fighting Techniques for Municipal and Rural Fire Departments Using Conventional Fire Apparatus and Equipment" and the April 1952 and Sept. 1951 issues of FIREMEN magazine.††

*Copies available from the Association at 35¢ and 50¢ respectively.

†Copy available from the Association at 50¢.

Other Aircraft Fires

There has been a total of 58 aircraft accidents involving fire reported to the NFPA during the period Jan. 1, 1952 to April 14, 1952. These 58 accidents have been responsible for 379 deaths.

††Reprints available from the Association for 25¢.

South Portland Dwelling Fire

Modern fire departments are doing an increasingly efficient job of fire fighting, but all too often fail to get proper credit for their good work. The spectacular large loss fires get the publicity while the fires that are extinguished with small loss don't make the headlines. Here is one such operation which reflects credit on the Fire Department.

A telephone alarm was received at 9:55 A.M. on December 28, 1951 from the first floor tenant of a 2½-story, wood frame dwelling in South Portland, Maine.

Fire Department response was with three engine companies and one ladder company. Upon arrival, the dwelling was well charged with smoke.

One 1½-inch hose line was immediately laid into the cellar, and a booster line with a fog nozzle attached into the first floor. The cellar ceiling was metal lath and plaster but fire was showing where a smoke pipe went through the ceiling from one of two hot air furnaces. Upon pulling the ceiling, fire fighters found the entire area back of the ceiling on fire.

Simultaneously, other fire fighters were ventilating the first floor. They found the fire had extended up through the first floor walls. Portions of the wall were opened on the first floor and fog used to extinguish flames within reach.

A second booster was then ordered to the second floor. This floor was so heavily charged with smoke that men with masks could not operate due to lack of visibility. A Fire Department 3600 cubic foot per minute air mover was brought to the second floor and used at a window. In less than 90 seconds, the air was clear enough so that the men could operate without masks. Salvage covers were then laid as the second story ceiling and one wall was pulled and the concealed fire extinguished with the single fog nozzle.

Roof boards on the house were not matched and the fire, passing up through the non-firestopped walls, communicated through the cracks in the roof boards to old wooden shingles that had been covered over by a new non-combustible roof covering.

Amazingly enough, only 60 gallons of water was used on the first floor and 75 gallons on the second floor to accomplish the effective extinguishment noted. The damage to the building was estimated at $2737, about 32% of the sound value of the property. The loss to the contents was $10. That's right, only $10! One pair of nice, new nylon curtains got too close to the air mover and came out in shreds. Chief Horace S. Jose reports that the lady of the household was furious!

Fire Protection For Chemicals - PART II

(PART I published in April Quarterly)

Charles W. Bahme

EDITOR'S NOTE: The following article ~~comprises a small part~~ IS THE SECOND INSTALLMENT of a manuscript prepared by Mr. Bahme for class instruction in fire protection engineering and for the training of members of the fire service charged with responsibility of safeguarding life and property against the fire and explosion hazards of dangerous chemicals. It should also be valuable reference material for the industries concerned with the manufacture, storage and transportation of chemicals, fire prevention authorities and others concerned with life and property safety.

Rather than delay publication until the manuscript could be published as a unit, the NFPA plans to make the information available by serial publication in the *Quarterly*. Readers are invited to submit their comments to the NFPA Executive Office.

The recommendations in this article are those of the author and do not necessarily reflect the official recommendations of the National Fire Protection Association, the U. S. Navy or the Los Angeles Fire Department.

Classes of Chemicals According to Hazard

While it is difficult to make generalizations about the various classes of chemicals as to whether or not they are usually hazardous, an approximate classification as to hazard is presented in Table 1. The Appendix* will contain a detailed list of more than 1,000 individual chemicals with indications of the degree of hazard of each. By way of preliminary consideration, the general classes of chemicals are subdivided into three groups:

1. Those which are generally nonhazardous,

2. Those generally hazardous from a fire or explosion standpoint, and

3. Those generally hazardous from the health standpoint.

It should be kept in mind that some of these classes may have specific chemicals which fall into other groups; the organic compounds of many groups of chemicals are hazardous, although their inorganic types may not be; e.g., sodium chloride (table salt) is considered nonhazardous but the alkyl (such as ethyl or methyl) chlorides, and other organic chlorides such as acetyl chloride and vinyl chloride are very dangerous. Also, for purposes of this list, classes which are merely combustible are not placed in the hazardous list, although it is readily apparent that they may become so when in contact with certain other classes, such as nitrates, chlorates, peroxides and other oxidizers.

Charles W. Bahme, member of the NFPA Committee on Hazardous Chemicals and Explosives, has been on active duty in the Office of the Chief of Naval Operations, in the capacity of Security Co-ordinator for the Navy. He has had more than 14 years of varied experience in the Los Angeles Fire Department, having been a firefighter, fire inspector, arson investigator and head of its Public Relations Bureau. He is an attorney, having membership in the California State Bar Association. At the time of Mr. Bahme's recall to active duty by the Navy, he headed the Dangerous Chemicals and Explosive Detail of the Los Angeles Fire Department in which capacity he drafted the "Dangerous Chemicals Code" for the city of Los Angeles.

*Not published in this excerpt of Mr. Bahme's text.

Table I

HAZARDS OF CLASSES OF CHEMICALS

Generally Non-Hazardous

Benzoates
Borates
Bromides
Carbonates
Chlorides
Citrates
Formates
Hyposulfites
Iodides
Lactates
Malates
Malonates
Molybdates
Oleates
Oxalates
Palmitates
Phosphates
Phthalates
Propionates
Salicylates
Silicates
Stannates
Stearates
Sulfates
Tartrates

Generally Fire or Explosion Hazardous

Acetals
Acetates
Acids
Alcohols
Aldehydes
Alkali metals
Amines
Ammonium compounds
Anhydrides
Antimony compounds
Azides and azo-compounds
Bromates
Carbides
Chlorates
Chlorites
Chromates
Chromites
Ethers
Fulminates
Halogens
Hydrides
Hydrocarbons
Hydrosulfides
Hydrosulfites
Hydroxides, solid
Hypochlorites
Hyponitrites
Hypophosphites
Iodates
Manganates
Metallic powders
Nitrates
Nitriles (see cyanides)
Nitrides
Nitrites
Nitro-compounds
Per-acids
Perborates
Perchlorates
Permanganates
Peroxides
Persulfates
Phosphides
Picrates
Pyrites
Pyrophores
Resinates of metals
Resins
Silicides of light metals
Styphnates
Sulfides

Health Hazardous

Alcohols
Acids, corrosive
Alkalis, caustic
Alkaloids
Aniline dyes and inks
Antimony compounds
Arsenates
Arsenic compounds
Arsenites
Barbituric acid derivatives
Barium compounds
Belladona derivatives
Benzene and derivatives
Chlorinated hydrocarbons
Cresols
Cyanides (or Nitriles)
Cyanogen compounds
Fluorides
Fumigants
Halogens (fluorine, bromine,, chlorine, iodine)
Hydrocarbons (aromatic and halogenated)
Hydroxides
Mercaptans
Mercury compounds
Metals—heavy and organometallic compounds
Morphine—derivatives and preparations
Oxalates
Phenols, derivatives and preparations
Phosphorous, or preparations
Radioactive substances
Selenates

Data on General Classes of Chemicals

Acetals

Acetals are organic solvents (diethers of alkylidine glycols), generally soluble in water, and ranging in flash point from 35°F. for dioxolane, to 310°F. for methyl "carbitol" formal. The group includes formal and butyrals. Acetals are used in synthetic rubber intermediates, plasticizers and solvents.

Dichlorethyl formal, used in making self-sealing (bullet-proof) gas tanks, has a flash point of 230°F., and carries a poison label. Avoid contact with skin or breathing vapors.

Acetates

Most organic acetates, such as cellulose acetate, are flammable. Most normal acetates are freely soluble, and are readily decomposed by strong acids or heat.

"Safety" film base, which is frequently cellulose acetate or cellulose acetate-butyrate, is considered no more hazardous than paper, either from a flammability standpoint or toxicity of products of combustion. (It should be remembered, however, that it is possible to inadvertently print the words "Safety Film" from an acetate negative on a nitrate print; a fire test, on a small piece, is one sure test.)

Acids, Inorganic

Hydrochloric, nitric and sulfuric acids are the most common members of this class. Where the acid contains more than the usual number of oxygen atoms it is called a *per* acid — e.g., $HClO_4$, or perchloric acid. The *per* acids are generally more dangerous, and usually the more concentrated a per acid is, the more hazardous. (See per-Acids.*)

*Not published in this excerpt of Mr. Bahme's text.

A strong acid is not necessarily a concentrated acid. The *strength* of an acid in solution is determined by how much it will ionize in solution, and varies with different acids.

The *concentration* of an acid depends upon the amount of water in which it is dissolved. Acetic acid could be very *concentrated,* having little water of solution, but would still be very *weak* because only slightly ionized.

Weak acids, such as acetic, carbonic, and lactic are poor electrolytes (not good conductors of electricity.)

Not all acids are corrosive; an example is boric acid, used for an eyewash.

Most acids are solid rather than liquid, and are combustible, particularly the organic acids. For example, formic acid (flash point 156°F.) and acetic acid (flash point 115°F.) are Class 3 flammable liquids, but solidify on cold days (47°F. and 62°F. respectively).

Hazards of Acids

1. CORROSIVE ACTION ON SKIN — or so-called "burn" — e.g., H_2SO_4.

2. TOXIC GASES GIVEN OFF — e.g., nitric oxides, hydrogen chlorides, etc.

3. VIOLENT RUPTURE OF VESSELS.

(a) Vapor pressure may cause carboy explosions; e.g., nitric, sulfuric, or hydrochloric acids, or mixtures of them. This action may be caused by the carboys being too close to radiators, prolonged storage in sun, or radiated heat from fire.

(b) Decomposition of acids, e.g. nitric and sulfuric acids, especially if warm, has been known to cause sufficient pressure to burst the strongest iron drums after a few hours exposure in the hot sun.

(c) Formation of hydrogen may occur

when acids are kept in metal containers, particularly dilute solutions. Concentrated sulfuric acid is transported in steel drums, but if moisture is absorbed, hydrogen will form that may rupture the container violently. (This recently occurred in a large drum of sulfuric acid in Los Angeles.)

(d) Violent shock may liberate gas from solution and burst the container; and when one breaks, others nearby may do so.

4. FIRE CAUSE. When in contact with combustible materials certain inorganic acids may cause fire. Strong nitric acid, probably the most common offender, may not only generate sufficient heat to cause ignition, but in the case of straw, paper, sawdust, etc., may nitrate the material to the point where it may become explosive. This ignition does not usually occur at once, however, delay in ignition varying from 35 to 45 minutes for concentrated nitric acid on hay and straw to 3 hours for more dilute solutions. In handling a nitric acid spill which was ill-advisedly absorbed in sawdust by employees, no ignition was observed in the course of an hour.

No record has been noted of hydrochloric acid causing fires in contact with ordinary combustibles; and as for sulfuric acid, gratings and planks in battery manufacturing shops have been charred from sulfuric acid spills, but very few cases of actual ignition have been reported.

Emergency Action — Acids

1. SPILLS

(a) Ventilate the area quickly.

(b) Use gas masks wherever toxic fumes such as nitric oxides are observed. Firemen have died as a result of breathing these orange-brown fumes for only a few minutes.

(c) Use a neutralizing-absorbent mixture wherever obtainable;—e.g., sodium carbonate (soda ash) and diatomaceous earth; (required to be provided near point of storage in airtight, labeled containers, in Los Angeles.) Small spills can be readily soaked up. If sawdust has already been used prior to arrival, mix in some soda ash or bicarbonate of soda to neutralize the acid and then scoop up the absorbed liquid and place it in a metal covered container pending final disposal; if sawdust is not neutralized, soak with water, and warn occupants against burning it in an incinerator.

(d) Flush spills with large volumes of water if out of doors or in areas where water will not cause additional damage. Flooding is not recommended for acid spills in chemical storerooms. A small amount of water may cause heating and violent spattering of water-reactive chemicals which may be present, such as calcium oxide or sodium hydroxide. The heat generated when a small amount of water is thrown into a tank of sulfuric acid may form steam and cause violent eruption.

(e) Throw on dirt, sand, talc, etc., where no neutralizer or water is available.

(f) Protect skin from burns — if sulfuric acid gets on hands, wipe as much as possible off on a rag; next clench fists (to keep out moist air) and go to a bucket of water or hydrant and rinse.

(g) Protect clothing — rubber boots are suitable for most mineral acids.

2. IF CARBOY IS BROKEN

(a) Neutralize, flush or absorb as indicated above.

(b) Move other carboys from the spill area, using care to avoid breakage.

3. CONTAINERS EXPOSED TO HEAT

(a) If drums and carboys are exposed by radiated heat from fire, keep them cool with water spray to prevent their bursting.

4. ACID PIPES

In plants where acid is piped within the building in lead tubes (usually suspended from ceiling or fastened to overhead supports), be careful to avoid any dripping acid. Heat-actuated shut-off valves on such lines help to reduce this danger.

5. OPEN VATS

Where open vats are present in buildings involved in fire—

(a) Avoid falling in—(should be covered at end of working day).

(b) Avoid throwing direct streams into tanks which may cause violent reaction or spattering. (Cases have been reported of empty drums which formerly contained oleum, for example, blowing up when hose streams were turned into them.)

6. GRAVITY TANKS

Where acid gravity tanks are on top of or inside of a building involved in fire, unprotected metal supports should be kept cool to prevent their collapse; keep out from under them.

Acids, Organic

The heavier organic acids resemble hydrocarbons in character, and are not very soluble in water. They are sometimes referred to as "fatty acids," for some occur naturally in animal fats; today most are made synthetically. Their derivatives are used in synthetic flavors, plasticizers, antiseptics, etc. They are generally stored in glass jugs, 5 and 12 gal. carboys, and 55 gallon stainless steel drums.

Most common of the organic acids is acetic acid, which is the base of acetate rayon, lacquers, plastics and motion picture safety film. Dilute acetic acid does not injure textiles, and so is used in laundry and textile industries.

The fire hazard of organic acids consists largely in their being combustible.

The following organic acids are all soluble in water; respective flash points of the undiluted acids are as indicated:

Acetic	115°F.
Butyric	170°F.
Ethylbutyric	210°F.
Caproic	215°F.
Ethylhexoic	260°F.

Alcohols

Alcohols are usually volatile and flammable. The flash point may vary from 52°F. for methyl (wood) alcohol, to 100°F. for butyl; ethyl (or grain) alcohol has a flash point of 55°F; most alcohols are required by the ICC to bear a red label. In general alcohols have a specific gravity of about 0.8; a vapor density of 2.5 to 3; and an explosive range of 3.5 to 18 per cent volume in air. The lower alcohols (with few carbon atoms) are readily soluble in water.

Alcohols are probably the most important industrial group of organic chemicals. The lower alcohols (with from one to three carbon atoms) are used in antifreeze compounds, germicides, and antiseptics. Methanol (CH_3OH) is the only alcohol that will dissolve cellulose nitrate.

The sulfate salts of the higher alcohols are used as wetting agents, emulsifiers and cleansing agents.

When dehydrated, alcohols yield ethers. They react with acids to form esters, and are easily oxidized to form aldehydes, ketones and organic acids. When combined with aldehydes they form acetals.

"Proof" indicates the alcoholic content of spirits and liquors. Spirits containing 50 per cent of alcohol by volume is known as "100 proof" in the United States; in England spirits containing 57 per cent alcohol by volume is "100 proof." Proofs of

the more common alcoholic beverages range from 50 to 140.

Since ethyl alcohol is the kind used in beverages, the term "alcohol" as commonly used usually refers to ethyl alcohol. When ethyl alcohol is made unfit for human consumption, it is denatured by adding other liquids with a similar boiling point (to prevent their being easily distilled off), e.g., aniline oil, animal oil, benzene, butyl alcohol, pure wood alcohol, gasoline, pine oil, sulfuric acid.

Hazards of Alcohols

Butyl and methyl are two of the poisonous alcohols, acting even upon the skin. Alcohols should not be mixed with silver nitrate or mercury nitrate as explosive fulminates may be formed; nor with strong oxidizing acids; e.g., perchloric or permanganic, for they may spontaneously explode; their addition to highly concentrated hydrogen peroxide (H_2O_2) forms powerful explosives which can be detonated by shock.

A mixture containing less than 15 per cent alcohol will not burn continuously, even if heated to its boiling point. Higher concentrations must be diluted nearly to 15 per cent before fires go out, depending upon the temperature of the burning liquid.

Alcohol-water mixtures containing more than 20 per cent alcohol are flammable; hence, some wines stored in closed tanks create an explosive atmosphere when the liquid is at temperatures between 60°F. to 100°F., depending upon the concentration of alcohol.

Precautions in handling alcohols are generally the same as for any flammable liquid, and the fire fighting aspects are also similar, except that extinguishment can be expected by dilution with water as well as by cooling and smothering, and an "alcohol-type" foam powder is required.

Toxicity of methanol (methyl alcohol) vapors are about the same as for toluol and banana oil (amyl acetate) which is 200 ppm maximum permissible concentration for an 8-hour exposure. Ethyl alcohol vapor has a toxic threshold of 1000 ppm (the same as for butadiene).

Aldehydes

Aldehydes are usually volatile, flammable, soluble in water, and have a sharp penetrating odor. Liquid acetaldehyde, for example, has a flash point of –17°F., and an explosive range of 4 to 57 per cent by volume in air.

When oxidized, aldehydes become acids, and when reduced, become alcohols. They possess the widest range of chemical activity of any class of organic chemicals, and are used extensively in organic syntheses and in making dyes, perfumes, plastics, synthetic resins, etc.

Water can be used in fighting aldehyde fires, the same as for alcohol; care should be taken to avoid prolonged breathing of fumes.

Alkali Metals

Alkali metals are the chemical elements lithium, sodium, potassium, rubidium and cesium. All are very light, having a low specific gravity, and a low melting point; they are silver-white and ductile, and react vigorously with water to form hydroxides.

Most of these metals are shipped in sealed, airtight containers, drums or in tank cars; occasionally they are kept under a hydrocarbon liquid, such as kerosene, to avoid accidental exposure to the air.

Molten sodium is used in large quantities in treatment of metals, and has many other industrial uses, including the manufacturing of indigo dyes and as a heat transfer medium in exhaust valves.

Storage of Alkali Metals

Alkali metals should be kept in a dry, fire-resistive building; and where the quantity is large, the storage space should not be used for any other purpose.

Alkali metals should not be stored in basements, nor in rooms where they may be exposed to water; this does not preclude the storage of small sealed containers, such as are found in laboratory stockrooms, in an area equipped with an automatic sprinkler system, but storerooms used exclusively for the storage of such materials should not be sprinklered. Store separately from acids, flammable liquids, combustibles, explosives, and oxidizing materials.

Hazards of Alkali Metals

These metals are all readily flammable at relatively low temperatures, and some, such as sodium, potassium and rubidium, ignite when moist. All decompose water violently to yield hydrogen, and in the case of potassium (K), rubidium (Rb), and Sodium (Na), ignite explosively.

Fumes in the form of finely divided caustic which are given off upon hydrolyzing in the air, irritate nose, throat, skin.

In contact with the skin, burns are produced; these burns should be washed with volumes of cold water before being neutralized with vinegar or dilute acetic acid. The affected part should then be coated with a burn ointment and medical attention sought. Eye burns should be washed with cold water followed by a 3 per cent boric acid solution; seek medical attention.

Fire Fighting—Alkali Metals

Care should be taken to avoid wetting containers which are not sealed air-tight, for the action of water on exposed sodium, for example, would only make the situation worse. According to one of the manufacturers of sodium (who asserts that it is shipped in quantities ranging as high as 80,000 pounds) the preferred material for extinguishing sodium fires is fine, dry, soda ash. Throwing liberal quantities of this material over the surface of the burning sodium will quickly extinguish the fire by absorbing the moisture present, and cold sodium, particularly when an oxide covering has formed over the surface, will not burn spontaneously in air unless it is finely divided.

Special chemical compounds, such as G-1 powder, can be used. Dry sand is also satisfactory, but care must be taken, for sand may still be wet when it appears dry.

Water, foam, soda-acid, carbon dioxide or carbon tetrachloride should never be used on fires involving sodium, potassium or the other alkali metals mentioned above. Carbon dioxide in any form as well as carbon tetrachloride, react violently with hot sodium.

Where the metal is submerged in hydrocarbon liquid, such as kerosene, a fire in the liquid can be extinguished by carbon dioxide, and there will be no reignition because the blanket of solvent vapor prevents the sodium from catching fire.

Since the material melts at low temperature (e.g., sodium melts at 207°F.), care must be exercised even in applying dry powders so as not to cause any splattering of the molten liquid.

When overhauling, be careful not to get alkali metals on the bare hands, in order to avoid serious burns.

Remember, that if the sodium, potassium, etc. have been kept in airtight containers in a proper fire-resistive building or cabinet, there is not so much likelihood of their offering any problem in fire fighting; water could be used as usual to extinguish any fire in other portions of the building.

Alkalis (Caustics)

Caustic soda (NaOH) and caustic potash (KOH or lye) are probably the most common of the caustics in use today; they are shipped in both the solid and liquid form. In the solid form, the ICC does not regulate, but the liquids must be shipped in tank cars, tank trucks, steel drums, etc., according to ICC specifications. Tank cars bear the DANGEROUS placard, and the other containers have the corrosive liquid label.

The liquid form comes in various concentrations, varying from about 50 per cent to 73 per cent by weight for caustic soda, for example. The solid form may be cake, flake, ground or powdered.

Caustic solutions are extensively used to clean metals, in making soap, pulp and paper, textiles, rayon, manufacture of reclaimed rubber, etc.

Storage of Alkalis

Chemical Safety Data Sheets SD-9 and SD-10* give relevant data and precautions for the handling and storage of caustic soda and caustic potash, respectively.

Caustics should be kept in a dry location, not below ground level, and, unless in water-tight sealed containers, should not be stored beneath automatic sprinklers. The storage building for large quantities of the solid materials should preferably be noncombustible or fire-resistive, in order to reduce the likelihood for need to employ fire hose streams in areas where these materials are kept.

Keep caustic alkalis away from acids, moisture, explosives, trichlorethylene, and combustible materials.

Hazards of Alkalis

Caustic soda, caustic potash, etc., are noncombustible, but react with water to generate heat; this is also true of the concentrated liquid solutions. With caustic soda for instance, boiling can be obtained by diluting 73 per cent solutions with water.

The most severe hazard is the destructive effect on living tissue. Deep painful burns are caused by contact of the solution on the skin . . . burns that may become running sores for years. A 10 per cent solution splashed in the eyes will permanently blind. A small fleck under the finger nail will be very painful.

In contact with water, the very dry solid materials will react violently, generating heat which may be sufficient to ignite combustible materials under some conditions.

Solutions of the caustic may generate hydrogen in contact with zinc, galvanized metals, or aluminum, for example, which may result in a hydrogen explosion if a source of ignition is present. Such an explosion occurred in a large Los Angeles brewery in its enclosed bottle washing tanks; the hydrogen was apparently ignited by an electric motor near one of the vent holes. Another flash explosion occurred in a plant making a drain cleaner, when the apparently damp mixture of caustic soda, sodium nitrate and aluminum shavings gave off hydrogen in the 1000-lb. mixer, and somehow was ignited. The situation was made worse when employees dumped a foam extinguisher into the hopper leading to the mixer, causing another flash, and followed with a straight stream from an interior standpipe hose. The whole building was filled with hydrogen and white fumes when firemen arrived, and several of them were severely burned about the feet from wading (with ordinary shoes) in strong caustic solutions.

*Published by the Manufacturing Chemists' Association, Inc., 246 Woodward Building, Washington 5, D. C.

Fire Fighting—Alkalis

If the use of water is necessary to control a fire where these substances are stored (and this precaution also applies to calcium oxide and calcium hypochlorite—with the added danger in the latter case that it yields oxygen) containers which are effectively sealed will present no difficulty, but if any are open, or the materials are exposed to water, they should be flooded thoroughly to obtain sufficient dilution to render the substances noncorrosive before the solutions reach the sewers.

Be careful to avoid open vessels. At a fire in Milwaukee, a fire department officer lost his life when he slipped and fell into a vat of caustic soda.

In overhauling, cover any open drums, and be careful not to get any of the material on the skin to avoid painful burns. If some is accidentally splashed on the skin, flood with water and apply vinegar or diluted acetic acid; then treat as a burn.

Small spills of the caustic solutions can be washed off and then sprinkled with soda ash or bicarbonate of soda to remove the last traces.

Alkaloids

Many of these organic bases, such as morphine, strychnine, atropine, cocaine, and quinine, are of medical importance. However, they can be very poisonous, and vapors of the volatile compounds, toxic. Like most organic compounds, they are combustible.

Amines

Amines generally have a characteristic ammonia odor, are more water-soluble than alcohols, and generally more volatile. They are used as corrosion inhibitors, for purification of fuel gases by removal of hydrogen sulfide (H_2S) or CO_2, and in the formation of emulsifiers for polishes, cosmetics, insecticides, water paints and cutting oils.

Fire Hazard of Amines

Most of the amines will burn, having a wide variation in flash points; for example, ethylamine flashes below 0°F., butylamine has a flash point of 45°F., while most are over 100°F., e.g., monoethanolamine, which has a 200°F. open cup flash point.

Ammonium Compounds

Ammonium compounds have the NH_4 group in their formulas. Many are explosive, such as ammonium bromate, chromate, chlorate, dichromate, nitrate, nitrite, perchlorate, permanganate, persulfate, picrate, sulphnitrate, etc., being susceptible to detonation by varying degrees of shock and sometimes by heat. Some are flammable and are skin irritants, such as ammonium dichromate, which when burning in a small fire, gives a striking resemblance to an erupting volcano, progressively increasing in intensity and rate of propagation. Ammonium dichromate is also explosive in contact with various substances.

When properly segregated in storage from other oxidizers and also from flammable liquids, flammable solids, corrosive liquids, etc., the above compounds would not necessarily present an explosion hazard in case the storage building should become involved in fire. Be sure to ascertain the characteristics of the particular ammonium compound, however, for some are nonflammable and relatively nonhazardous, such as ammonium hydroxide (aqueous ammonia — spirits of ammonia), while others like ammonium nitrite are very unstable and will detonate at temperature above 158°F.

Table 2

Properties of Typical Anesthetics

	Form	Flash Point (a)	Ignition Temperature (a)	Explosive Range (b)	Sp. Gr. (Water=1)	Vapor Density	Boiling Point (a)	Toxicity PPM (c)	Water Solubility
Chloroform (trichloromethane). $CHCl_3$	Liquid	Practically non-flam.		....	1.4	4.1	142	100	Slightly
Cyclopropane (Trimethylene).. $CH_2CH_2CH_2$	Gas		928	2.4-10		1.4	−29	400	No
Diethyl Ether (Ether)..... $C_2H_5OC_2H_5$	Liquid	−49	356	1.8-36.5	.71	2.5	95	400	Yes
Divinyl Ether (Vinyl Ether)... $C_2H_3OC_2H_3$	Liquid	−22	680	1.8-36.5	.77	2.4	102		No
Ethyl Chloride (Chloroethane). C_2H_5Cl	Liquid	−58	966	3.7-12	.91	2.2	54	1000	Slightly
Ethylene (Ethene)..... C_2H_4	Gas	...	842	2.75-28.6	...	.97	−155	...	Slightly
Propylene (Propene) ..... C_3H_6	Gas	...	927	2.0-11.1	...	1.49	−58	...	Yes
Nitrous Oxide (Laughing Gas). N_2O	Gas	...	Nonflammable	.....	...	.937	−129	...	Slightly
Oxygen (d)..... O_2	Gas	...	Nonflammable	.....	...	1.1	−297	...	Slightly
Helium (d)..... He	Gas	...	Nonflammable	.....	...	.136	−450	...	Slightly

(a) All temperatures are Fahrenheit. (b) Explosive range is per cent by volume in air. (c) Toxicity is based upon an eight-hour exposure period in parts per million. (d) Used in conjunction with anesthetics. No data available on substances for which no entry made.

Fire Fighting—Ammonium Compounds

Some ammonium compounds give off toxic gases when heated. Where large amounts of orange-brown smoke are present, use self-contained type of mask.

Water from hose streams can be used effectively on water-soluble compounds, and practically all ammonium compounds are soluble, although some are coated to make them insoluble. Where a salt is in a molten state, however, water streams may cause spattering and steam eruptions.

Where certain ammonium compounds, such as ammonium nitrate, are heavily confined, as in the hold of a ship, detonation may result during the course of the fire. If a ship containing large cargoes of ammonium nitrate becomes involved in fire, its removal should be commenced (from congested areas) before starting extensive fire fighting operations. If flooding fails to extinguish the fire within an hour, it should be scuttled in a remote area or be put to sea and the ship abandoned when further fire extinguishing efforts fail to control the fire. (See **Fertilizers*** and **Nitrates*** for additional comments on ammonium nitrate.)

Anesthetics

An anesthetic (formerly spelled anaesthetic) is a chemical used for producing a loss of sensation. A *general* anesthetic is one which affects the whole organism, such as ether, chloroform, or nitrous oxide, while a *local* anesthetic is one which affects only a particular part of the body, such as ethyl chloride, novacaine, or cocaine.

As indicated in Table 2, most of the commonly used anesthetics are highly flammable, and have been involved in numerous surgery explosions and hospital fires.

*Not published in this excerpt of Mr. Bahme's text.

Hazards of Anesthetics

With the exception of ethylene, most of the anesthetic gases (including ether vapors) are heavier than air and may be carried by drafts to a source of ignition. Moreover, nitrous oxide or oxygen are often administered at the same time in order to maintain respiration, with the result that the mixtures used have frequently a wide explosive range.

Since the vapors of ethyl ether have an explosive range of 1.8 to 36.5 per cent in air, the vapor from a gallon bottle of ether may make 1,777 cu. ft. of air explosive; its vapors are 2½ times as heavy as air and will travel along the floor where they may reach a flame, or any object heated to 366°F., which can cause ignition.

The formation of spontaneously explosive peroxides and ether hazards in general are discussed under **Ether.***

Although open flames under sterilizers, cauteries, radio knives, diathermy, electrical switches, breaking of light bulbs, etc., are some of the possible sources of ignition, the principal cause of explosions in operating rooms (and in the lungs of patients) is believed to be static ignition of these flammable anesthetic mixtures.

The sources of ignition first mentioned can easily enough be eliminated, but the elimination of the static hazard is more difficult. Table 3 illustrates how easily static can be generated:

Table 3

Static Generation

Activity	Voltage Generated
Walking 20 ft. on the floor	1000-1500
Sitting on stool	500
Scuffing feet on tile floor	2000-3000
Covering patient with blanket	2500
Pulling cloth cover off operating tables	3000-4000

On the basis of tests reported in "Anesthesiology," Volume 2, No. 2, March,

1941, it was recommended that static potentials in operating rooms never exceed 1200 volts. (It was found that the gas mixture would not explode with a voltage less than 1375 v. to ground or 1450 v. to an ungrounded electrode.)

Reducing Static Hazard

The principal methods suggested for reducing static hazard include:

1. ELIMINATION OF "INSULATORS." Materials which tend to impede the flow of static charges to objects of lower potential, such as nonconductive rubber, wool, nylon, rayon, etc., should be kept out of the zones of danger.

2. HUMIDITY CONTROL. Although beneficial in preventing the building up of static potentials, the maintenance of a relative humidity as high as 65 per cent cannot prevent the generation of static charges of sufficient potential to cause an explosion.

3. INTER-COUPLERS. Devices having several leads employing one-half to one megohm resistance between leads and 250,000 ohms to ground, are used to intercouple the patient, anesthetist, surgeon, and other assisting personnel, in order to equalize the static potentials between them and thereby prevent a static discharge. While there are certain advantages to these devices, their use has not eliminated all hazard (in the absence of further safeguards), and hence is not recommended as an alternative for conductive flooring in the NFPA's Recommended Safe Practice for Hospital Operating Rooms.

4. CONDUCTIVE FLOORING. Conductive floor covering, having not less than 25,000 nor more than 500,000 ohms resistance to ground, together with the use of conductive rubber casters, conductive shoes, bonding of patient to table, and table to floor, etc., appears to be a satisfactory method of dissipating electrostatic discharges.

Unless other precautions are taken in the electrical installations, there may still be some hazard from electric shock to personnel; moreover, unless conductive compounds are used, the floor may be rendered nonconductive by a film of wax or similar material.

5. STATIC INDICATORS. While not intended to replace any recommended safeguard, devices can be used to test persons entering a room, and some will give an audible warning of approaching danger.

Anesthetic Concentrations Used*

When ether is given by open mask or closed system, it requires from 3 to 20 per cent concentration to effect anesthesia; cyclopropane in oxygen requires from 5 to 30 per cent; ethylene in oxygen requires 80 to 85 per cent which is above the explosive range.

If the total amount of nitrous oxide and oxygen in the anesthetic mixture does not exceed about 30 per cent, the violent explosions can be eliminated.

Nonflammable concentrations of helium-oxygen-cyclopropane mixtures can be obtained in mixtures of 40 per cent or more of helium, 7 to 30 per cent oxygen. Oxygen must be kept to below 18 per cent when 10 per cent cyclopropane is present, and as the amount of cyclopropane is increased, the per cent of oxygen can be varied accordingly; e.g. if 30 per cent cyclopropane is used, the amount of oxygen must be below 32 per cent.

The explosive range for cyclopropane-nitrous oxide-helium mixtures is 21 to

*Information in this section of the study on anesthetics was obtained from U. S. Dept. of Interior, Tech. paper 653, "Explosion Hazards of Combustible Anesthetics," by G. W. Jones, R. E. Kennedy and G. J. Thomas.

30.3 per cent and cannot be made nonflammable. Nor can ether-nitrous oxide-helium mixtures be employed which are outside the flammable limits.

However, according to the tests of Professor J. W. Horton* a mixture of oxygen, cyclopropane and ethylene in proportions of 40-40-20 is outside of the explosive range, and other adjustment of the proportions can be made to effect the desired degree of anesthesia while still maintaining sufficient oxygen for respiration.

Department of Interior tests indicated that a satisfactory nonflammable anesthetic mixture can be obtained by the addition of helium in sufficient amounts to cyclopropane and oxygen, and to cyclopropane-ether-oxygen mixtures.

The Army Medical Corps has been doing development work on a nitrous oxide-pentothal combination, which has eliminated any explosion hazard; 80 per cent nitrous oxide (or less) is sufficient to provide the analgesia (without danger of anoxia), while the relaxation and anesthesia is provided by the use of pentothal intravenously.

Summary of Anesthetic Hazards

Since many medical authorities still find that flammable anesthetic mixtures are highly desirable, their use should not be prohibited, but carefully regulated.

Although the use of closed rebreathing systems for the administration of anesthetic agents normally tends to restrict the hazardous region, the use of flammable anesthetics with mixtures of air, oxygen or nitrous oxide are nevertheless attended by considerable risk of explosion where basic safeguards have not been established. Such explosions may occur spontaneously when flammable gases and oxygen are inadvertently mixed under high pressure, and also by simple ignition.

Although X-ray, electric cauteries, diathermy, etc., have initiated many explosions, these dangers are now fairly well recognized,** with the result that static discharge now appears to be the hazard of greatest significance.

Maintenance of 50-60 per cent humidity in the operating room while tending to prevent the building up of static charges, does not appear to have entirely removed the possibility of explosion from this source.†

Mechanical ventilation of surgery rooms is also desirable, but appears to have had little effect on the type of anesthesia gas explosion that has resulted in fatalities.

In the absence of a break in the tubing, leak in the apparatus, sudden removal of the mask, etc., the explosion zone for most anesthetics appears to be confined to within a foot or two of the patient's face. Thus it is the mask area and not the room as a whole which is the danger point.

Shock by defective electrical equipment seems to be almost as great a hazard as gas explosion to operating room personnel, unless the proper safeguards have been provided.

The hazard of static generation can be lessened by the elimination of materials such as non-conductive rubber, wool, nylon, rayon, etc., from the operating room; its dissipation can be furthered by the use of conductive floors, shoes, bedding, casters, etc., along with humidification.

*Mass. Institute of Technology, 1940; reported on p. 322 of NFPA Handbook of Fire Protection, 10th Edition (1948).

**Barnett A. Greene, M.D., New York, presented papers on the above subjects in Surgery, Gynecology and Obstetrics (1942), Vol. 74, pp. 259-265; 895-900.

†W. P. Morrill, M.D., "Progress in Prevention of Anesthetic Explosions," in *Hospitals*, May, 1940; he stated that at least one explosion had been reported as having been due to static electricity in the presence of a relative humidity in excess of 60 per cent.

Differences in electrical potential between various "capacitors" in the room can be equalized through intercoupling devices, although these may not eliminate the hazard with reference to "uncoupled" persons having a different potential who may come in contact with personnel wearing leads from the intercoupler device. However, floor plates and testing equipment can be installed at the entrance to the room, and other devices can be utilized which give an audible warning signal in the event that any person carrying a static potential approaches the danger zone within the room.

Having provided proper mechanical safeguards, the "human element" must still be reckoned with; the best equipment is worthless if the personnel refuse to use it, or fail to follow the rules and regulations established for the safety of all concerned.

Storing and Handling Anesthetics

Cylinders should be ICC approved, with color markings conforming to the National Bureau of Standards† and labeled with the chemical name. Small cylinders of anesthetic gases, approximately 4½ inches in diameter by 25 inches long or smaller should also bear color markings. Spare containers should be kept outside in a locked ventilated enclosure, or in a fire-resistive room, preferably sprinklered, and properly vented to the outside. (See the NFPA Recommended Safe Practice for Hospital Operating Rooms for typical requirements of a gas storage room and for general precautions relating to cylinder handling.)

An example of how improper storage of this chemical may result in a serious hospital fire is the case involving the breaking of a large glass bottle of "waste" ether that had been stored in a cabinet near the floor in a sterilization room, located between two surgery rooms; the vapors were instantly ignited by open flames under the sterilizers, and although CO_2 extinguishers were immediately put to use by the nurses, the fire spread very rapidly to the adjoining rooms. Owing to the intensity of the fire and smoke discharging into the halls, a complete evacuation of the hospital was necessary.

The use of small, sealed, one-fourth pound cans of anesthetic ether has largely replaced the practice of filling small containers from larger ones. However, wherever any dispensing of ether or other flammable liquids is done, it should preferably be in a small isolated building away from the main building. If it is utilized or dispensed in a pharmacy within the hospital itself, the amounts kept on hand should be small, and the room should be of fire-resistive construction, and meet all the requirements of a flammable liquid dispensing room as to fire doors, sills, ventilation, electrical equipments, etc.**

†Color markings recommended in Simplified Practice Recommendations R-176-41 issued by the Division of Simplified Practice, National Bureau of Standards, Washington D. C.

Oxygen	green
CO_2	gray
Nitrous oxide	light blue
Cyclopropane	orange
(Chromium plated cylinders are not painted orange, but have an orange label or tag)	
Helium	brown
Ethylene	red
CO_2 and oxygen	gray
Helium and oxygen	brown and green

**See NBFU Special Interest Bulletin No. 115, "Handling Ether in Hospitals," for a discussion of such safeguards. See NFPA pamphlets No. 56, "Recommended Safe Practice for Hospital Operating Rooms," and No. 565, "Nonflammable Medical Gas Systems." See also "Hospital Fire Safety," published by the NFPA. Also see "Fire Prevention and Protection as Applied to Hospitals," published by the NBFU in 1942.

Cylinders of oxygen and nitrous oxide should be stored separately from containers of flammable gases and liquids, and away from combustible materials. Inert gases, such as helium and CO_2 can be safely stored with either the flammable or oxidizing gases.

Piping, manifolding, and oxygen chambers should comply with the recommendations set forth in the NFPA Recommended Safe Practice for Hospital Operating Rooms and NFPA Standards for Nonflammable Medical Gas Systems.

Surgery Rooms

The following are typical precautions:

1. Low pressure steam and hot water heating only — no open flames.
2. Portable electrical appliances to be of a type approved for use in a hazardous location. (Only 3-wire "S" type cords and approved outlets can be used.)
3. All lighting fixtures less than 5 feet above the floor to be explosion-proof.
4. Sparking devices, such as motors, telephones, etc., are prohibited unless of a type approved for use in hazardous locations.
5. If electrocautery must be used in an operation, hospital regulations should require that the surgeon select a nonflammable anesthetic, except that cautery may be used in the presence of combustible anesthetics if, in the judgment of the surgeon, failure to do so would jeopardize the patient's life and the surgeon accepts personal responsibility for so doing.
6. Static protection must be provided.

Fire Fighting—Anesthetics

The difficulty in extinguishing fires involving ether is discussed under **Ether.*** Remember that although both diethyl and divinyl ether are lighter than water, and although diethyl (which is ordinary ether and the same as ethyl ether) is water-soluble, water is not considered a very effective extinguishing agent for either. Extinguishers employing carbon dioxide, dry chemical or carbon tetrachloride have been found the most satisfactory of all materials tried, particularly when used in conjunction with water spray to prevent a "flash-back."

Ethyl chloride is a liquid with an even lower boiling point than ether (often shipped in cylinders), and similar measures are applicable. Remember, that it is often more advisable to allow gases and extremely volatile liquids, such as ether and ethyl chloride, to burn while protecting exposures from the flames, than to extinguish the fire and allow dangerous concentrations of gases or vapors to collect in an area where an explosion might result.

With respect to gases in cylinders, it is generally considered the best policy not to extinguish flames burning at a leaking valve or hose unless the valve can be shut off; keeping the cylinder cool with water, as well as any others which may be exposed, is good practice; if the cylinder is mounted on a cart or wheeled machine, it may be possible to keep it cool and roll it outside. Other hose streams can be used to extinguish or control any fires started in adjacent materials.

Should the gas fire be accidentally extinguished, the leak should be plugged if possible, or else the cylinder be instantly taken outside so as to avoid filling the building with gas and thereby creating a risk of explosion.

Ethylene is lighter than air, and diffuses readily, but cyclopropane and propylene are heavier than air, and may remain in low places unless adequate draft is provided.

*Not published in this excerpt of Mr. Bahme's text.

Nitrous oxide and oxygen are not flammable, but will support combustion, oxygen being the better oxidizing agent.

Chloroform is a practically nonflammable liquid, having burning characteristics similar to trichlorethylene (see **Chlorinated Hydrocarbons**), while helium is a nonflammable, inert gas.

If summoned to a hospital as the result of an operating room explosion, it is more than likely that no serious fire will be present; the damage will have been done already, and the best thing to do then is to have an expert investigation made of the cause of the accident, in order to take measures to prevent another.

Anhydrides

Acid anhydrides are organic acids from which the water has been removed. Hence, they will react with water (and sometimes violently) to regenerate acids. They are usually liquids, and act as dehydrating agents, as in nitration and sulfonation. For example, acetic anhydride $(CH_3CO)_2O$ is added (very slowly, owing to the heat formed) to 72 per cent perchloric acid in making up an electropolishing solution. Following the electropolishing bath explosion in Los Angeles (for report see QUARTERLY Vol. 40, No. 4, P. 275), it was asserted that the above reaction tended to produce anhydrous perchloric acid of such a strength as to be relatively unstable, particularly at elevated temperatures.

Fire Hazard of Anhydrides

The fire hazard is usually greater for anhydrides than for the corresponding organic acids, since the flash points of the liquids are lower. For example, acetic anhydride has a flash point (open cup test) of 121° F.; propionic anhydride, 165°F.; butyric anhydride, 190°F.; and maleic anhydride, 240°F.

Health Hazard of Anhydrides

Anhydrides are very irritating to the eyes, nose, throat and nasal passages, and therefore contact with the skin or exposure to the concentrated vapors should be avoided. Acetic anhydride, for example, has a recommended toxic limit of 5 ppm per eight hour exposure.

Aniline Dyes and Inks

Aniline ($C_6H_5NH_2$) is a colorless or slightly brown liquid, which is poisonous by absorption through skin, digestive organs, as vapor or dust in respiratory organs or by food contamination. It is slightly soluble in water. The California Division of Industrial Safety places a toxic threshold for aniline at 5 ppm for a working period.

Fire Hazard of Aniline

Flash point data for aniline oil shows a variance from 43°F. to 168°F., but it is likely to be over 100°F. See MCA Safety Data Sheet SD-17* for precautions. Although long used in dyes, recent experiments in producing a mixture of nitric acid and aniline which is spontaneously flammable indicate its possible use in self-propelled missiles. Fire extinguishing tests on such a mixture, using fog and dry powder, indicate that while either one separately may fail to effect extinguishment, a combination of both can be successful.

Antimony Compounds

These compounds are generally poisonous; the fumes of antimony powders, or molten metal are toxic and irritating. It is used in type metal. When highly heated, antimony burns with a brilliant light, forming antimony trioxide (Sb_2O_3). The recommended limit for antimony fumes, dusts and vapors is 0.5 milligrams per cubic meter.

*See footnote, page 350.

The metal spontaneously ignites in chlorine. Its sulfides are highly flammable and are used as a component in matches and primer compounds. Its pentasulfide (Sb_2S_5) is also flammable. The sulfides are insoluble in water but yield poisonous hydrogen sulfide in contact with acids. Antimony pentachloride and antimony pentafluoride are both corrosive liquids requiring the ICC white label.

Antimony sulfate is a white powder, used in explosives and pyrotechnics, and is said to be explosive. Its triethyls and trimethyls are spontaneously flammable in air. Antimony powders should be stored well away from acids, in a dry location.

Arsenates and Arsenites

These compounds are salts of arsenic acid and arsenous acid, respectively. For example, sodium arsenate is Na_3AsO_4. Like all arsenical compounds, they are poisonous if taken internally. Keep away from foodstuffs, living quarters and away from acids. Their dusts have a recommended toxic limit of 0.5 milligrams per cubic meter.

Azo-Compounds

Azides are salts of hydrazoic acid (azoimide N_3H) made by action of nitrous acid on hydrazine. They are compounds containing the N_3 group, e.g., benzyl azide ($C_7H_7N_3$), which is a liquid, insoluble in water.* Hydrazoic acid is a colorless liquid and a sensitive explosive.†

Azides are also referred to as compounds of metal with nitrogen or nitrides; e.g., lead azide, which is insoluble, and is comparable to fulminate of mercury in explosiveness.

Various azides were reported by Marshall† to be used as initiators of detonation, especially silver, copper and lead azides. These can develop their full explosive effect even when unconfined, whereas fulminate of mercury has to be confined in a thin metal case to get full effect.

Sodium azide is a poisonous solid, but is not explosive; however, it *may* form very sensitive compounds in contact with certain metals, especially copper.

The diazo compounds are a group of very reactive organic nitrogen compounds which are formed when nitrous acid acts at low temperatures upon the salts of a primary aromatic amine, such as aminobenzene (aniline). They are usually explosive and hence are not isolated in their crystalline form, but used in solutions as intermediates in manufacturing dyestuffs.

Barbituric Acid Derivatives

The acid consists of white crystals which are slightly soluble in water; it is used in the preparation of pharmaceutical chemicals. Derivatives include barbital, pentobarbital, phenobarbital, etc.

Benzene and Derivatives

For discussion of the fire hazard of benzene, toluene, xylene and other members of this class (see **Hydrocarbons**).* For treatment of effects of inhalation of vapors, give oxygen inhalation and artificial respiration if necessary. Benzene (benzol), for instance, has a recommended toxic threshold of 50 ppm for a working period exposure.

Benzoates

These compounds are generally nonhazardous. They are the salts of benzoic acid. The acid is composed of white crys-

†Hackh, Ingo W. D., Chemical Dictionary (P. Blakiston's Son & Co., Phila., 1929).
†Marshall, Arthur, "Explosives," Vol. II. (Three volumes, Churchill, London, 1917 to 1932.)

*Not published in this excerpt of Mr. Bahme's text.

tals with a flash point of 250°F. Sodium benzoate is used extensively as a food preservative.

Borates

The borates are salts of boric acid, such as sodium borate (Na_3BO_3). Sodium tetraborate ($Na_2B_4O_7.10H_2O$) is the familiar borax, used in flameproofing compounds. (Do not confuse with sodium perborate ($NaBO_3.4H_2O$), which is an oxidizing agent.)

Bromates

The bromates are salts of bromic acid containing the BrO_3 group, e.g. sodium bromate ($NaBrO_3$). They are similar in hazard to chlorates, although they react less violently. See **Oxidizers.***

Bromides

Bromides which are soluble in water, such as sodium, potassium and ammonium bromides, are used in the preparation of certain sedatives. Most are non-hazardous from a fire standpoint, though some organic compounds react violently with water, e.g., acetyl bromide, which is a fuming liquid with irritating vapors. Vinyl bromide is a highly flammable gas with a boiling point of 60°F., a vapor pressure of 6 psi at 70°F.; it is very irritating. Ethyl bromide is a flammable liquid, has an explosive range 6.7 to 11.2 per cent, ignition temperature 952°F., vapor density 3.7, and has a very irritating vapor; it is not soluble in water. Most inorganic bromides, however, are soluble in water. (See **Halogens*** for a discussion of the hazards of bromine, and **Fumigants,*** relative to methyl bromide.)

Carbides

The carbides of some metals, such as those of sodium and potassium, may react explosively on contact with water. Some carbides decompose in water to yield acetylene, namely, lithium carbide (Li_4C), potassium carbide (K_4C), calcium carbide (CaC_2), strontium carbide (SrC_2), and barium carbide (BaC_2).

Methane is formed when the carbides of aluminum (Al_2C) and Boron (B_2C) decompose in water.

Hydrogen and methane are formed by the carbides of magnesium (MgC_2), manganese (Mn_3C) and chromium (Cr_3C). The carbides of rare earths (atomic number 58 to 72 of periodic system) form a mixture of hydrogen, methane and acetylene. Those of the rare metals thorium (ThC_2) and uranium (UC_2) form solid, liquid or gaseous hydrocarbons. One carbide, silicon carbide (SiC), also known as carbon silicide (CSi) and carborundum, is very stable. Gold carbide, on the other hand, does not react with water to yield gas, but explodes under shock, percussion, or heating.

Calcium carbide, although not of itself flammable, is the compound generally used to generate acetylene industrially; exposure to humid air can cause this explosive gas to be released. Containers should be kept tightly closed, in a fire-resistive, dry, well-ventilated location.

Fire Fighting—Carbides

Where acetylene gas is burning above wet calcium carbide, it will rise through any blanket of CO_2 applied, and the use of dry powder is not recommended, nor will the application of water, foam, soda-acid, or fog extinguish the fire, but water streams or fog may be helpful in cooling exposed containers and in protecting surrounding property. It is generally inadvisable to attempt to extinguish such a fire, for acetylene will continue to be generated, and if not sufficiently wet to cool the heat of reaction the gas may spontaneously reignite, with possible explosion.

*Not published in this excerpt of Mr. Bahme's text.

Formation of explosive gases is not the only fire hazard connected with carbides; they also generate heat in contact with water, comparable to the manner of quicklime. For example, when one-third its weight in water is added to carbide, the temperature may reach 1472°F., which is sufficient to ignite the acetylene generated.

Sodium carbide becomes heated to incandescence when placed in chlorine, carbon dioxide or sulfur dioxide.

The handling of calcium carbide is regulated by ordinances in most cities which closely follow the recommendations in the NFPA Standards for the Installation and Operation of Gas Systems for Welding and Cutting (NFPA No. 51).

Carbon Compounds

Some carbon compounds are flammable, such as the hydrocarbons, while others are not; pure crystallized carbon (the diamond), is not flammable, nor is graphite.

Activated carbon is a charcoal produced by the destructive distillation of vegetable matter, such as fruit pits, nut shells, etc. It is used in gas masks to absorb organic vapors, also to decolorize sugar solutions, oils, fats, etc.

Activated carbon is potentially a more dangerous fire hazard than charcoal. It should not be mixed with bleaching powder in a dry state (or any other oxidizer), for an explosion may result.

Activated carbon should not be stored in a dry state with chlorine, oil, gas, etc., because of the danger of spontaneous ignition. Keep away from heating devices. It is classed by the ICC as a flammable solid, yellow label.

Any charcoal is more susceptible to spontaneous ignition upon subsequent drying after being wetted, and has a high tendency to heat spontaneously in any case. Keep dry. Supply ventilation.

Carbonates

Carbonates are the salts of carbonic acid, containing the CO_3 group; the bicarbonates have the HCO_3 group. Carbonates and bicarbonates of the alkali metals are soluble. They are generally nonhazardous.

Chlorates

Chlorates are the salts of chloric acid and contain the ClO_3 group. They are colorless crystals or fine white powders, and are usually soluble in water.

Fire Hazard of Chlorates

Chlorates tend to liberate oxygen explosively under influence of friction, shock, concussion, or heat (at 752°F.). According to Von Schwartz, "All these salts (chlorates) are highly explosive and dangerous."

Chlorates are strong oxidizing agents, and when mixed with organic materials form very flammable mixtures. For example, the use of chlorates is now generally prohibited in a weed killing solution (except in small amounts in combination with boric acid, borax, caustics, etc.), owing to the fact that the sprayed weeds, upon drying, become dangerously flammable; operators spraying such solutions have been seriously burned as a result of spills or splashes drying upon their clothing, and subsequently becoming ignited by friction.

When mixed with finely divided organic matter, such as the dust on a loading wharf, as a result of spills, such mixtures may ignite when stepped on. A recent explosion in a Washington, D. C. university, in which four were killed and three injured, occurred when boxes of sodium chlorate were being removed from the building. The chlorate probably became mixed with organic material and may have been ignited by friction.

All chlorates when brought in contact with sulfuric acid (and certain other strong acids) are liable to cause fire or explosion, evolving explosive chlorine peroxide gas.

When mixed with ammonium salts, chlorates are liable to decompose spontaneously and ignite.

Chlorate mixtures containing sulfur, sulfides, etc., are extremely sensitive to blows or friction. In one instance, a process involving mixing of potassium chlorate and sulfur had been in use 20 years before it blew up and killed one man and two women in an adjacent building.

Neither chlorates nor perchlorates are allowed as major ingredients in permissible explosives.

Explosions may occur when breaking up chunks of chlorates. When chlorates are mixed with potassium cyanide, oxygen is immediately disengaged with explosive violence.

Chlorate drums may explode when heated.

Fire Fighting—Chlorates

Chlorates are soluble in water, and therefore hose streams can be used on fires involving chlorate storage. Keep drums cool to prevent oxygen release and violent rupture of the drums. Spilled chlorates should be flushed with plenty of water to a location where they will do no harm upon subsequently drying. Combustible materials which have been soaked with chlorate solutions may ignite spontaneously when dry.

Chlorides

Most chlorides, like sodium chloride (table salt) are nonhazardous. Some organic chlorides, such as vinyl chloride and ethyl chloride, are extremely flammable. Vinyl chloride, which is shipped as a gas, has a boiling point of 68°F., flash point of 0°F., explosive range 4 to 22 per cent, vapor density 2.15, and must be inhibited. Vinylidene chloride is a flammable liquid with a flash point of 14°F., explosive range 7 to 16 per cent and must also be inhibited to prevent polymerization; when exposed to air it forms an explosive peroxide compound, and its vapors are harmful. All are soluble except those of silver, mercury and lead. (Lead chloride is readily soluble in hot water.)

Chlorinated Hydrocarbons

Health Hazards

(Applies also to fluorinated and brominated hydrocarbons.)

Chlorinated hydrocarbons are principally a health hazard. For example, the toxic threshold (maximum permissible concentration) for chlorinated diphenyls or naphthalenes is one milligram of dust per cubic centimeter; the toxic threshold in parts per million for carbon tetrachloride is 50, and for chloroform 100. (Compare with carbon monoxide, which is also 100 ppm.)

By way of further comparison, the amount of vapor (per cent in air) which will kill most animals in a very short time, has been given as follows (from the NFPA Handbook of Fire Protection, 10th Edition, page 328):

Table 4

Concentrations of Common Gases and Vapors Killing Most Animals in a Very Short Time

Gas or Vapor	Per Cent by Volume
Ammonia	0.5
Benzene	1
Gasoline	2.4
Methyl bromide	2 to 4
Carbon tetrachloride	4.8 to 6.3
Chloroform	6.8 to 8.2
Ethyl bromide	10 to 20
Methyl chloride	15 to 30
Ethyl chloride	15 to 30

Table 5

Flammable Refrigerants

	Ignition Temperature	Explosive Range
Dichlorethylene	860	5.6 - 13
Ethyl bromide	952	6 - 11.2
Ethyl chloride	966	3.6 - 14.8
Methyl bromide	999	13.5 - 14.5 (weak flame)
Methyl chloride	1170	8.2 - 19.7
Methylene chloride	1224	Prac. non-flam.
Freon 21	1026	Prac. non-flam.
Freon 22	1170	Prac. non-flam.
Freon 113	1256	Prac. non-flam.
Trichlorethylene	770	15

Probably the most toxic of all the chlorinated hydrocarbon solvents in industrial use is tetrachlorethane ($CHCl_2$-$CHCl_2$), also called acetylene tetrachloride. The Manufacturing Chemists' Association estimates its toxicity rating at 5 ppm for maximum allowable exposure for an 8-hour day, and recommends a label to indicate that it is poison.* Not only are its vapors extremely dangerous to inhale, but they are also poisonous by skin absorption.

Hazard in Fire

When involved in fire (exposed to flames), some of the chlorinated (or brominated) hydrocarbons, even in concentrations as low as 0.5 to 2.5 per cent, will decompose to form phosgene, chlorine and other toxic substances. Typical of these are certain freons, carbon tetrachloride, chloroform, methyl bromide and methyl chloride. For a complete discussion of the hazards of carbon tetrachloride and methyl bromide, see **Fumigants.**† With respect to chloroform, see **Anesthetics,** and for methyl chloride, see **Refrigerants.**†

Flammability

Many halogenated hydrocarbons are not flammable at ordinary temperatures and pressures. However, some of the halogenated refrigerants which are more or less flammable are shown in Table 5.

Several fires have occurred in connection with degreasers utilizing trichlorethylene vapor. These devices generally consist of tanks heated by open gas flames, and if the liquid is not changed frequently enough it becomes acid in nature, causing leaks in the tank; when it comes in contact with flames it burns with considerable smoke. Although the ~~Manufacturing~~ Chemists' ~~Association~~ gives the flash point of trichlorethylene as 90°F. when in contact with an intense source of ignition, it gives a flash point for ordinary sources of ignition such as flames and sparks, at 122°F. and upward.** By actual tests, however, the liquid does not continue to burn for long after the source of heat is removed. Therefore, where the liquid is burning in the pit around the degreaser tank, shutting off the gas supply to the burner will usually extinguish the fire. Self-contained breathing apparatus should be worn when entering a room filled with

*M.C.A. Safety Data Sheet SD-34 (1949) points out that tetrachloroethane is nonflammable and nonexplosive, but may explode with sodium, postassium, or their alloys, and upon being heated with solid potassium hydroxide, yields a spontaneously flammable gas (which may be chloracetylene). Ventilation should be provided for storage areas to the extent of at least 12 air changes per hour, and its use should be only in closed systems.

†Not published in this excerpt of Mr. Bahme's text.

**~~Safety Data Sheet SD-14, p. 6.~~ Pub. by MCA

smoke and fumes from any fire involving chlorinated hydrocarbons.

Perchlorethylene (tetrachlorethylene, or carbon dichloride) is less combustible than trichlorethylene, but it is considered by some to be more toxic; however, the Manufacturing Chemists' Association suggests a maximum of 200 ppm for an 8-hour exposure for either one.

When the oxygen concentration is increased, the spray flammability of halogenated hydrocarbons is increased. (See Industrial and Engineering Chemistry, Dec., 1947, p. 1607, "Flammability of the Higher Boiling Liquids and Their Mists," by members of the U. S. Naval Research Laboratories.) The greater the number of chlorine atoms per molecule, the more oxygen is required. For example, chlorodiphenyl ether, with one atom of chlorine per molecule, has a flash point of 260°F. in 27 per cent oxygen; dichlorodiphenyl ether (with 2 atoms of chlorine per molecule) has a flash point of 300°F. and requires 35 per cent oxygen, while the trichloro compound has a flash point of 325°F. and requires 42 per cent oxygen to support combustion.

Certain chlorinated hydrocarbons may react with other substances to produce a dangerous material. For example, trichlorethylene may react with strong alkalis, such as caustic soda, to produce the explosive dichloracetylene, and if the hot vapors of chlorinated hydrocarbons are brought in contact with powdered aluminum, an explosion results.*

Chlorites

Chlorites, salts containing the ClO_2 group, are derived from chlorous acid. They are bleaching agents which react like hypochlorites but their decomposition requires higher temperatures and the resulting explosion is more violent. They are powerful oxidizers, for which the same precautions should be taken as for chlorates. See **Chlorates** and **Oxidizers.**†

Chromates

Chromates are salts of chromic acid which contain the CrO_4 group, e.g., Na_2CrO_4, sodium chromate. Chromates are extensively used in paint pigment. Potassium chromate, for example, consists of yellow crystals, used in aniline black, and is required to have a warning label in California with respect to the health aspects of its harmful dust.

Although these salts are oxidizers, they do not present an appreciable fire hazard. When heated with sulfuric acid they ignite any organic matter present.

Chromites

Chromites are salts of chromous acid, containing the CrO_3 group, with characteristics similar to chromates. Also known as "chromite" is an oxide of iron and chromium, which contains about 68 per cent of chromic oxides.

Citrates

Citrates are salts containing the $C_6H_5O_7$ group, derived from citric acid. Magnesium citrate for example, is a white, odorless, crystalline substance of a pleasant acid taste, used in a purgative preparation. These salts are generally nonhazardous.

Creosote Oil

Creosote oil is used as a wood preservative. Smoke given off from creosoted pilings, etc., may be very irritating, and a fire in freshly creosoted wood will spread with great rapidity. Creosote oil has a flash point of 165°F. Extinguishing agents for Class B fires would be suitable.

*R. Cecil Smart, "The Technology of Industrial Fire and Explosion Hazards," Vol. II, p. 26 (1947), Chapman & Hall, London.

†Not published in this excerpt of Mr. Bahme's text.

Cresols

Health Hazard

Cresols are poisonous; they are used as disinfectants.

Fire Hazard of Cresols

Cresol compounds are combustible. For example, o-cresol (o-methyl phenol) has a flash point of 178°F. and melting point of 188°F; and p-cresol (cresylic acid) has a flash point of 187° F. and melting point of 95°F.

The use of water spray or other suitable extinguishing agent for a Class B fire should be satisfactory.

O and p-cresol are only slightly soluble in water, and are slightly heavier than water; their vapor densities are 3.72 times that of air.

Cyanides

Cyanides (or nitriles), compounds containing the group CN, are derived from hydrocyanic acid (HCN). They are used in electroplating, heat treating, fumigation, etc., and are usually in solid form, packed in air tight metal or fibreboard containers.

Health Hazards of Cyanides

When acted upon by acids or moisture, some cyanides give off HCN (hydrocyanic acid or prussic acid) which is deadly poisonous and flammable. (.048 per cent kills most animals in a very short time.)

Cyanides are extremely poisonous and should not be handled with bare hands. Open vats of cyanide solutions should not be in the same room with open vats of hydrochloric (muriatic) acid, as the latter gives off hydrogen chloride gas, which, if mixed with cyanide vapors, forms HCN, especially if the air is moist. In pickling operations, acid and cyanide baths should preferably be in different rooms. Keep cyanides stored in a dry location, separate from acids, and when in fibreboard containers, a few inches above the floor.

Fire Hazards of Cyanides

Cyanides are not usually combustible, but become molten at elevated temperatures, at which time they may yield small amounts of flammable vapor. The principal concern to fire fighters is from poisoning, either by inhalation of the HCN formed where dry cyanides are wetted, or by skin absorption of cyanide solutions which may be spilled (or be formed where open drums of the solid are overturned by hose streams during fire-fighting operations). The use of respiratory protection is recommended under such conditions.

Two factors tend to offset the toxic hazard, as far as HCN is concerned. First, it is slightly lighter than air, and will tend to be swept up with the heated air by convection currents; second, it is soluble, and will go into solution if fog or water streams are used, thereby tending to remove the gas from the atmosphere.

Carbon dioxide extinguishers should not be used where dry cyanides are involved, particularly if the air is moist, or where water spray is also being used, as the carbonic acid formed will tend to accelerate the evolution of HCN. The above comments also apply to calcium cyanide dusts, flakes, granules, etc. (mixed with inert ingredients), used for pest control by nurseries in plant fumigation, although possible to a lesser extent. See **Fumigants.***

Explosion Hazard of Cyanides

The National Safety Council states that floors should be kept dry around cyanide baths, as the cyanide will explode when dropped on wet floors — probably referring to the possibility that the HCN gas formed would be ignited by the open flame burners under the tanks.

*Not published in this excerpt of Mr. Bahme's text.

Cyanides should never be added to molten nitrate or nitrite baths (or vice-versa), for a disastrous explosion can result. A small nitrate bath (14 in. by 24 in. by 9 in. deep) exploded at about 450°F. when sodium cyanide "eggs" were added, tearing out a 10 ft. by 15 ft. section of the roof, a portion of a brick wall and breaking windows in other buildings.

As to the explosion hazard of HCN, see **Fumigants.**

Cyanogen Compounds

Cyanogen compounds include the following: cyanogen halides; cyanogen fluoride (NCF),—chloride (NCCl),—bromide (NCBr),—iodide (NCI), all of which are soluble and poisonous. The bromide and iodide are solids; the chloride a liquid or gas, and the fluoride a colorless gas. Vapors are heavier than air.

Also sometimes included are the various cyanides, ferrocyanides and ferricyanides, the hazards of which have been presented under the heading of **Cyanides.**

Cyanogen is a water-soluble, colorless, pungent, poison gas at temperatures above 70°F., which burns with a purple tinged flame. Its vapor density is 1.8 in campari-son to air. At temperatures below 70°F. it is a flammable liquid. Cylinders of compressed cyanogen are required by the ICC to bear the poison gas label. Compressed cyanogen has been listed in a recent volume on explosives, along with TNT, tetryl, nitrocellulose, nitroglycerin, ammonium nitrate, ammonium perchlorate, dynamite and compressed acetylene as an example of a high explosive.*

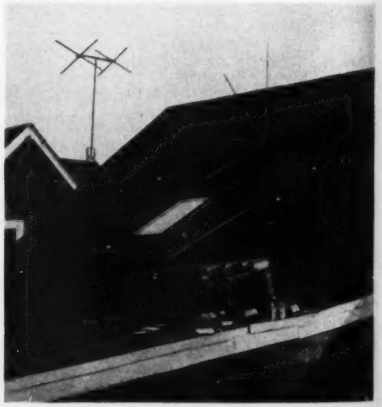
*Davis, Tenny L., "Chemistry of Powder and Explosives," p. 3 (Wiley & Sons, N. Y., and Chapman & Hall, London), 1943.

TV Antenna Wrecks Chimney

In the July 1951 NFPA *Quarterly,* an article on "Television and FM Antennas" prepared by Mr. Charles L. Smith, NFPA Electrical Field Engineer, attracted an unusual amount of interest. Reprints of the article designated No. Q45-1*, have been widely circulated.

To emphasize the importance of proper antenna installations, the Kenwood Engineering Company of Kenilworth, N. J., manufacturers of "Kenco" eave and parapet mounts for antennas, submitted the photograph of the chimney mount failure published here. This photo was taken in Newark, New Jersey, following a storm in November 1950.

*Copies available from the NFPA Publications Service Department for 25¢ per copy.



TV antenna collapsed this two-flue chimney in Newark, N. J. in a windstorm. NFPA recommendations urge eave mounting. See July 1951 *Quarterly* or Reprint Q 45-1.

Paper Storage Fire, Louisville

Fire at Warehouse M of South Dixie Warehouse, Louisville, Kentucky, should eliminate any doubt of the susceptibility of rolled paper to serious fires if any remained after the recent fire in Rochester, New York,* and the earlier fire in Miami.† Approximately 11,000,000 pounds of magazine print paper in rolls was practically destroyed by fire that started on January 11 and was not completely extinguished until several days later. Total loss was estimated at $1,340,000.

Construction and Protection

Warehouse M (formerly a foundry) was an undivided one-story building approximately 195 feet long by 125 ft. wide with several small additions. Walls were mostly of corrugated aluminum on wood nailing strips attached in turn to the steel frame of the building. A large monitor typical of foundries, extended the length of the roof. Most of the roof was of corrugated iron on wood nailing strips; the remaining was composition on wood sheathing.

No sprinkler, automatic detection equipment or watchman service was provided. Private protection consisted of fire extinguishers.

Contents

Contents was primarily magazine print in rolls, piled five tiers high with two-inch by six-inch wood dunnage between tiers. A carload of baled wool and a quantity of baled back issues of magazines were also stored in the building. Clear space consisted of a central aisle running the length of the building and a short side aisle extending from the center aisle to the loading platform.

The Fire

At 5:00 P.M., January 11, a foreman and four warehousemen came on duty to load trucks with paper rolls and to transfer paper from freight cars to the warehouse. After completing the truck loading shortly before 10 P.M., and before starting to unload freight cars, the men stopped for a rest period and lit an oil-fired salamander in the yard about eight feet from the buiding.

The rest period was just about over and the men were returning to the warehouse when a light explosion in the vicinity of the salamander called their attention to a fire burning at the salamander and along the adjacent aluminum clad wall of the warehouse.

One of the men connected a garden hose to a faucet in the warehouse office, others tried to smother the fire with sand. It is possible that the fire could have been controlled with relatively minor damage had the fire department been able to make a strong attack promptly. Information on fire department notification differs but fire officials estimate that at least 10 minutes elapsed before the alarm was telephoned at 10:10 P.M. while employees attempted to control the fire. Fire department operations were further hampered

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Based on reports submitted by the Louisville Fire Department and the Kentucky Inspection Bureau.

*See NFPA Quarterly, Jan. 1952, page 235. Reprinted Q 45-11 (25¢).

†See NFPA Quarterly, Jan. 1950, page 163.

Louisville Fire Prevention Bureau

The sides of this aluminum clad warehouse in Louisville were quickly consumed but the surface of paper rolls and wood dunnage between rolls continued to burn for several days. The prompt disintegration of the aluminum enclosure may have made fire fighting easier.

by the telephoned information that the fire was a "yard fire," which called for dispatch of one engine company.

Firemen arriving from the station two blocks away found one end of the building in flames and fire spreading rapidly through the undivided interior. Since the responding engine was not equipped with two-way radio and since the office telephone was by then out of commission, response of additional apparatus was delayed until called by a telephone from a restaurant. Second and third alarms were struck at 10:18 and 10:19 P.M., bringing a total of 13 engine companies, two ladder companies and a quad to the scene. Twenty-eight pumper streams, one hydrant stream and two booster lines were placed in operation but because of the speed with which the flames spread through the interior of the building and the limited aisle space, firemen were forced to attack the blaze from the outside and concentrate on preventing involvement of wood pallets piled ten feet high adjacent to the building and a warehouse ten feet away.

Most of the wood roof portion and the aluminum siding was quickly consumed and heat-weakened steel beams and girders collapsed. However, the surface of the paper rolls and the wood dunnage between rolls continued to burn and hose streams were still being used to extinguish deep seated smoldering between the rolls five days later.

An interesting side light is the effect of the fire on the aluminum siding which was almost totally consumed during the early stages. Some of the siding melted but the clouds of fine white residue (believed to be aluminum oxide) that settled over the neighborhood indicates that the aluminum siding was for the most part destroyed by combustion.

Meeting of Board of Directors

New York, January 24, 1952

Present

A. H. S. Stead, President
Allen L. Cobb. Vice-President
T. S. Duke, Vice-President
Hovey T. Freeman, Secretary-Treasurer
Richard E. Vernor, Chairman

A. L. Brown
C. H. Bunn, Jr.
Loren S. Bush
James E. Frederickson
R. D. MacDaniel
John Neale
H. E. Newell
Geo. J. Richardson
R. C. Sogge

Percy Bugbee, General Manager, Robert S. Moulton, Technical Secretary, Horatio Bond, Chief Engineer, Charles S. Morgan, Assistant General Manager, M. M. Brandon, Chairman, Electrical Section.

Business Transacted

1. General Manager Bugbee reported on plans and the preliminary program for the 1952 annual meeting to be held in New York June 9-13. It was voted to approve these plans and authorize the NFPA Executive Office to proceed accordingly, subject to approval of further details by the Program Committee.

2. Treasurer Freeman reported on the finances of the Association indicating a healthy financial condition, but a recurring difficulty in meeting obligations during the early months of the Association's fiscal year, a period when expenditures normally exceed income due to the fact that the large proportion of the NFPA income is normally received in the latter months of the fiscal year. With the increasing size of NFPA operations the need for working capital to meet expenses during the first part of the fiscal year is increasingly great. Accordingly, on motion of Treasurer Freeman it was voted to authorize the General Manager, subject to approval of the Advisory Committee, to sell such bonds held by the NFPA as may be necessary to produce adequate cash reserves.

3. Executive Office reports were presented as follows:

(a) **Membership.** Mr. Bugbee reported that the membership of the Association had just passed the 14,000 mark and described current activities in membership promotion.

(b) **General Publications.** Mr. Moulton reported on the technical and educational publications issued during the year 1951 and indicated a great increase in dollar volume of publications sales as compared with the previous fiscal year.

(c) **Advertising.** Mr. Morgan reported on the current advertising situation, indicating a substantial increase over last year.

(d) **Special Engineering Projects.** Mr. Moulton reported on the satisfactory functioning of the Flammable Liquids field engineering project and on the prospects for establishment of a similar project on Gases. Messrs. Bunn and Newell reported general satisfaction with the Flammable Liquids field service project and the work of the Flammable Liquids Engineer.

(e) **Fire Marshals' Section.** The Fire Marshals' Section activities were reported by Mr. Morgan, who indicated that the section is now functioning smoothly.

(f) **General Educational Projects.** Mr. Bugbee reported on Fire Prevention Week, the Advertising Council project, and the work of the NFPA Public Relations Department, indicating a very substantial increase in activities in this field, and made special mention of the Fire Prevention Week contest, the administration of which has now been assumed by the NFPA office, and of the Advertising Council project which has received widespread acceptance and support. He emphasized the fact that the Advertising Council project is operated in the interest of general education in fire prevention and is not operated specifically as an NFPA project.

All of the above reports were approved.

Regional Meetings

4. President Stead, Board Chairman Vernor, and others discussed the regional meetings held in Portland, Ore. on October 24-25 and Los Angeles on October 29-30. There was general agreement that these and other regional meetings have been very valuable and that regional meet-

ing activities should be continued and extended as opportunity presents. The Board expressed appreciation to Fire Marshal Miles Woodworth, General Chairman of the Portland regional meeting, to Board member John Alderson, Chairman of the Los Angeles meeting, and others whose cooperation was instrumental in the successful conduct of these meetings. Plans for 1952 regional meetings in Cleveland on October 27-29 and Houston, Texas, December 1-3, as reported by staff members were approved.

5. Mr. Bugbee reported on the NFPA Sponsors Committee of which Henry D. Sharpe, President of Brown and Sharpe Company of Providence, has been Chairman and the members of which are a distinguished group of industrial leaders. Mr. Bugbee reported that Mr. Sharpe has presented his resignation as Chairman. It was voted to accept this resignation with an expression of sincere appreciation to Mr. Sharpe for the contribution of his services to the NFPA. All Board members were requested to consider the selection of a successor to Mr. Sharpe and to communicate their suggestions to Mr. Bugbee.

6. In conformity with the recommendation of the NFPA Committee on Farm Fire Protection, Mr. Bugbee presented to the Board proposals that (a) the NFPA sponsor a contest among volunteer fire departments to stimulate interest in farm and rural fire prevention and fire protection, and (b) to provide a full time field engineer to serve as Secretary of the Committee on Farm Fire Protection and generally promote fire protection and prevention activities in the rural field, this employee to be supported by special contributions for this purpose. These proposals were approved by the Board in principle and referred to Mr. Bugbee for exploration of possible ways and means for putting these projects into effect. Mr. Bugbee was requested to report to the Board on these matters at the next meeting.

7. M. M. Brandon, Chairman of the Electrical Section and of the Electrical Correlating Committee, reported on the activities of this group and described the work now under way looking towards the preparation of a 1953 National Electrical Code.

8. John A. Neale, Vice-President of the Society of Fire Protection Engineers, an NFPA Section, reported for the Society indicating satisfactory development of this activity on a self-supporting basis.

9. Allen L. Cobb, Chairman of the Industrial Committee, reported on developments in this field.

Technical Activities

10. Mr. Moulton reported the results of prior conferences between staff representatives of the members of the American Standards Association Fire Protection Group which consists of the NFPA, the Associated Factory Mutual Fire Insurance Companies, the National Board of Fire Underwriters, and Underwriters' Laboratories, Inc. He reported the agreement of this conference that Fire Protection Group participation in ASA affairs as conducted under the name of the Group should be limited to policy-making and administrative levels and that participation on technical levels in sectional committees under ASA procedure should be between several members of the Group acting individually. In conformity with further recommendations from this conference as presented by Mr. Moulton, the following actions were taken:

(a) It was voted to nominate Mr. M. M. Brandon of Underwriters' Laboratories a member of the ASA Standards Council for a three-year term beginning January 1, 1952 to succeed Curtis R. Welborn.

(b) A. J. Steiner of Underwriters' Laboratories was appointed NFPA representative to the Safety Code Correlating Committee to take the place of H. L. Miner, retired.

(c) M. M. Brandon of Underwriters' Laboratories, with K. S. Geiges, alternate, was appointed NFPA representative to the Electrical Standards Committee and U. S. National Com-

mittee of the International Electro-Technical Commission.

(d) It was voted that the NFPA assume joint sponsorship in place of the Fire Protection Group joint sponsorship for the following projects organized under ASA procedure: Cotton Rubber Lined Fire Hose, Fire Tests of Materials and Construction, and to instruct the NFPA office to take the necessary steps to put this change into effect.

(e) It was voted to send a letter to the Building Code and Construction Standards Correlating Committee of ASA suggesting that building code activities be suspended.

11. Chairman A. L. Brown reported for the Committee on Technical Committee Procedure recommending confirmation of committee appointments as submitted to the meeting, also confirmation of those appointments delegated to the Committee on Technical Committee Procedure by action of the Board at its last meeting and incorporated in the 1951-52 Year Book subject to Board confirmation.

Committee Organization

12. A further report for the Committee on Technical Committee Procedure was made by Mr. Brown as follows:

(a) We wish to report that the work of the Committee on Flammable Liquids has been reorganized in the interest of more efficient operation, without change in voting procedure, with its standard-drafting functions distributed among six subdivisions as follows:

Sectional Committee on General Storage and Handling
C. H. Bunn, Jr., Chairman
Sectional Committee on Transportation
George W. Clough, Chairman
Sectional Committee on Classification, Labeling and Properties
J. Sharp Queener, Chairman
Sectional Committee on Liquid Fuel Burning Equipment
E. F. Tabisz, Chairman
Sectional Committee on Maintenance and Repair Operations
R. T. Henderson, Chairman
Sectional Committee on Dry Cleaning
John Hommes, Chairman

We request approval of this rearrangement of the committee.

We have under consideration a similar reorganization of the Committee on Dust Explosion Hazards but are not prepared to report thereon at this time.

(b) We have considered the organization of the proposed field service project on gases as referred to us by the Board at its last meeting, and recommend that, subject to the receipt of sufficient contributions, this project be established as a separate project to be administered by a committee separate from the present Flammable Liquids Field Service Sponsoring Committee, but without necessarily having completely different personnel.

(c) We have received on behalf of the Board, a communication from the Committee on Hospital Operating Rooms, requesting that the electrical provisions of our Standards on Hospital Operating Rooms (No. 56) be incorporated in the National Electrical Code. We are referring this to the Electrical Correlating Committee for comment and in due course will report our recommendations to the Board.

(d) We have received from the Committee on Aircraft Hangars a recommendation that the scope of this project be amended by limiting it to construction and protection, with the appointment of new parallel Committees on Aircraft Engine Test Cells, and on Aircraft Maintenance and Storage Operations, both reporting to the Association through the Committee on Aviation and Airport Fire Protection. We have requested the Committee on Aircraft Hangars to give further consideration to the subject of test cells in the light of information that has become available since their last meeting, and will report at a later time any recommendations that we may have on this subject.

We recommend approval of the proposed Committee on Aircraft Maintenance and Storage Operations, and request authority to proceed with the formation of this committee subject to subsequent Board confirmation of the personnel.

(e) We have given consideration to a suggestion from the National Board of Fire Underwriters that the official NFPA definition of the word "shall" be modified to avoid any implication that either the NFPA or the NBFU assumes any authority in the enforcement of standards and might thereby be subject to possible liability in connection with the application of standards. We sympathize with the thought underlying this suggestion, but have not been able to arrive at any different definition which would satisfy this point without at the same time weakening our standards. We feel that the title "Standards" does not imply any police power and that perhaps there is no need for any change in our present use of terms. We are of the opinion, however, that legal advice might be helpful and have asked the NFPA staff to consult with their legal counsel on this matter.

(f) Various other matters of committee procedure and organization are under consideration, with a view to presenting recommendations at some subsequent meeting of the Board.

The several recommendations listed above were approved.

13. Mr. Moulton reported on the distribution of the NFPA Handbook of Fire Protection (Crosby-Fiske-Forster) indicating that the present tenth edition published in 1948 would be exhausted in 1953 if the present rate of distribution continues. It was voted to authorize the NFPA staff to proceed with the editorial work for the preparation of an 11th edition of the Handbook to be issued in 1953, and to empower Chairman Vernor to appoint an advisory committee to act on behalf of the Board in working with the NFPA office and approving the text for publication.

Chairman Vernor thereupon appointed the following committee: A. L. Brown, Chairman, John H. Alderson, Hylton R. Brown, A. L. Cobb, J. A. Neale.

14. Messrs. Bugbee and Bond reported on NFPA staff activities in relation to the national emergency, particularly in respect to matters of civil defense. Messrs. Duke and Richardson reported on the situation with respect to fire equipment and materials. There was general discussion but no specific action on these matters.

15. On recommendation of Code-making Panel No. 15 of the National Electrical Code Committee, K. S. Geiges, Chairman, it was voted to record with the American Standards Association concurrence in the approval of the 1951 revision of the Standard on Power-Operated Radio Receiving Appliances, ASA No. C65.1-1942, submitted by Underwriters' Laboratories under the proprietary sponsorship method.

Hospital Operating Room Electric Circuits

By Roy Hudenburg

Secretary, NFPA Committee on Hospital Operating Rooms and Secretary, Council on Hospital Planning and Plant Operation of the American Hospital Association

In providing an explosion safeguard system for hospital operating rooms, many elements are needed, but unless the hospital includes them all and develops a complete program, the system is worthless. In many cases, for example, explosion-proof electrical fittings and conductive operating room floors are installed in hospitals as standard equipment with no follow-through on the attendant equipment and administrative safeguards necessary for proper protection. Not only does such a program fail to contribute anything to safety, but in most cases it actually increases the hazard of explosion and electrical shock.

Among the major elements of any program to control hospital operating room explosions are (1) a system for grounding all personnel and equipment to a conductive floor and (2) an isolated, ungrounded wiring circuit serving the operating suite.

The recent report of the Bureau of Mines investigations into static electricity in hospital operating room suites certainly can be counted on to bring a great deal of attention to the need for complete compliance with the National Fire Protection Association recommendations for hospital

This article, printed originally in the April 1952 issue of *Hospitals*, is reprinted here as an interesting and valuable example of the clear presentation of an important section of an NFPA technical standard in non-technical language that should be understood by anyone in this field. This article is also of interest as a further example of the fine cooperation the NFPA is receiving from the American Hospital Association.—Ed.

operating rooms. (See *Recommended Safe Practice for Hospital Operating Rooms,* Pamphlet No. 56 of the National Fire Protection Association). And inevitably, as the results of the Bureau of Mines findings are studied, it is to be expected that the grounding of surgeons and the nursing personnel with conductive shoes and the grounding of equipment with conductive caster will be given great impetus.

But as this increased compliance with standard recommendations develops, it is quite necessary that hospital authorities also study requirements for isolated, ungrounded circuits in hospital operating rooms. This is a feature of the requirements which, so far, has commanded little attention from anyone other than the electrical inspector and a few of the electrical engineers called on to make hospital layouts.

A conscientious effort is being made by flooring manufacturers to keep the resistance built into their floors in the general area, of the lower limits, now prescribed as 25,000 ohms. These floors are intended to equalize electrical potentials, which requires the surgeon and the nurse to be electrically connected to that floor by means of conductive shoes.

Even though this system does provide a substantial resistance to electricity between the individual coming in contact with a live wire and the ground, the protection against electrical shock is only relative. It is quite probable that the surgeon who touches a defective piece of electrical equipment will sustain a very definite sensation if his body is between the electrical circuit and the earth ground.

To protect operating room personnel against such unwelcome shock, Pamphlet 56 of the NFPA recommends the following very specific requirement:

"Section 5-5. Arrangements of Circuits

(a) In anesthetizing locations an ungrounded electrical distribution system is required to reduce the hazards of electric shock and arcs in the event of insulation failure. Alternating current circuits shall be insulated from the conventionally grounded alternating current supply by means of one or more transformers which isolate the circuits electrically from the main feeder and from other circuits in the building . . . etc.

(b) Direct current circuits shall be insulated from their grounded feeders. This may be accomplished by means of a motor generator set or suitable battery system.

(NOTE: *Where the main electrical service is alternating current, and the emergency service is direct current, or vice versa, it is advisable to arrange the circuits so that no circuits except those for lighting or designated emergency outlets are connected to the emergency service.*)"

Electrical current flows in a complete circle as in figure A. The flow of current is from the battery (or generator) through wires to the electric lamp and then back to the battery. When, as in figure B, the circuit is interrupted by the opening of a switch, (1) there is no flow of current and (2) the lamp does not light.

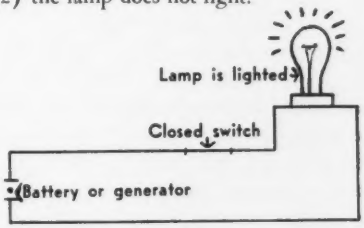


FIGURE A

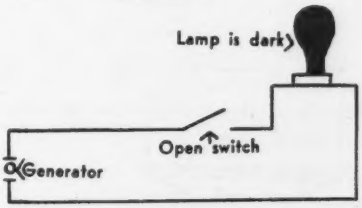


FIGURE B

Early in the history of electric power distribution, it was learned that the earth itself could be used as a return "wire" to complete the electrical circuit in the distribution of electricity. This means that if the power company runs one side of its generator circuit to the earth, it then can distribute current to consumers over a single wire, providing a ground wire to earth is connected to one side of the consumer's wiring system. (NOTE: Modern wiring utilizes a return wire to the utility sub-station as in figure B-1, but since that "grounded neutral" wire is at the same electrical potential as the earth ground, it will be disregarded in this discussion since it does not materially change the grounding shock hazard.)

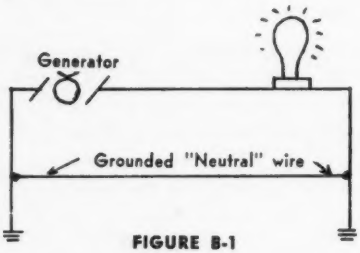


FIGURE B-1

The current which enters a home consists of two wires. One, called the "hot" wire, is fed from a distant generator, and the other, called the "neutral" wire, is connected to the earth outside of the consumer's property. (See figure C.)

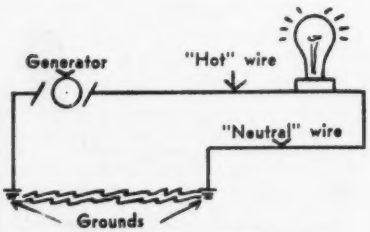


FIGURE C

The nature of this arrangement is such that a circuit can be completed anywhere along the hot wire, as in figure D, by carrying a drop through an appliance or light directly to the neutral grounded conductor. It is this property that provides the shock hazard when conductive floors are introduced into the operating room as illustrated in figure E, which shows a defective electrical appliance, a conductive floor connected to the ground (which is at the same time potential as the neutral conductor) and an individual wearing conductive shoes. In this figure the individual provides a path to earth ground for the electricity, although the amount of current passing is substantially limited by the resistance in the conductive flooring and the conductive shoes.

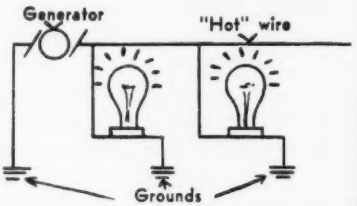
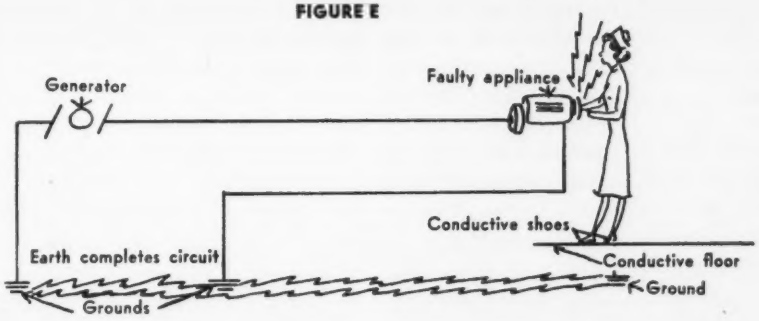


FIGURE D

Figure F represents the use of what is known as an isolating one-to-one transformer. In Figure F, the grounded circuit terminates at the transformer and the circuit feeding the operating room is a closed circuit which is not grounded. This is the ungrounded isolated circuit required for operating rooms under Section 5-5 of Pamphlet No. 56 as protection against shock hazard introduced by the installation of conductive floors and the wearing of conductive footwear.

It should be noted that these ungrounded electrical distribution systems are required for anesthetizing locations, but do not have to serve storage locations for com-

FIGURE E



bustible anesthetic agents, even though conductive floors are required for such storage areas.

Accidental Grounds

This wiring system is effective as protection against shock, only as long as it remains ungrounded. There are many opportunities for it to become grounded through defective wiring. If, for instance, in the system of conduits and conduit fittings through which the wires pass, there is any contact between a wire bared of insulation and the conduit system, this would form an accidental ground.

A much greater chance of accidental grounding occurs when electrical appliances are connected into the operating room circuit. To comply with the standard, all portable equipment intended for use in the operating room must have its outer non-electrical metal parts connected to the building ground by means of a third wire in the connecting electrical cord. This connects the appliance to the explosion-proof fitting which is designed to accept a three-terminal plug, of which one terminal is intended to complete the grounding of the metallic shell of the appliance to the building ground.

Any failure of insulation or other defect which causes the electrical system within the appliance to accidentally contact the grounded shell of the equipment, also would ground the entire electrical circuit. But unless it was readily apparent when the grounding did occur, this susceptibility to undetected grounding would nullify the effectiveness of the wiring system.

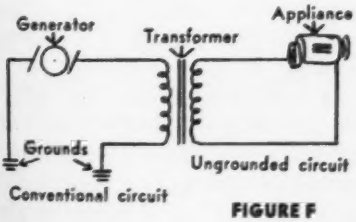


FIGURE F

Ground Detection Systems

Pamphlet No. 56, therefore, requires a ground detection system for every operating room. This detection system is so contrived that whenever either of the conductors in the circuit is grounded (as might occur when a defective appliance is plugged into an outlet) a signal is immediately given. As long as the system is safe and isolated from ground, the signal indicator in the operating room will show a green light. But the moment a ground occurs, the green light goes off, a red light goes on, and a buzzer system begins to function.

In some hospitals this alarm also is connected to an alarm in the maintenance

chief's headquarters so that he also will know if and when the system becomes grounded. It is most necessary, however, that the principal signal should show in the operating room, because it is the surgical personnel who must be protected against shock and who should know when they are in a position to receive such a shock from defective equipment.

There are various ways in which these warning systems work. The recommendations of the NFPA refer to a system operating by means of a relay, but a system which works by means of electronic tubes is equally acceptable.

The recommendations do specify, however, that there should be separate branch circuits feeding into each room used as an anesthetizing location. The reason for this is obvious, since the ground detector system should function only in the operating room in which a ground in the wiring system occurs.

In order to prevent inadvertent connection of ungrounded circuits to conventional circuits at some later date, the panel boxes feeding the ungrounded circuit should be physically separated from those feeding the conventional type of wiring. At the time of installation, the circuits should be specifically and clearly marked in the panel boxes as being ungrounded circuits, and a notice explaining the character of this electrical service should be posted by the hospital administration.

If the system is to be effective, its character, function and maintenance must be clearly explained to all personnel working in the operating rooms as well as to the maintenance staff. This is necessary if the safeguards are to receive proper respect and if the system is to be maintained so that it provides the required safety.

Compliance with these safeguards is not too difficult for most hospitals which are supplied alternating current by public utilities. Hospitals which have old direct-current generators that they themselves operate or which are in central areas of larger cities having direct current, however, probably will have quite a problem.

Where Direct Current Is Used

Electrical transformers are effective only for alternating current. The simple procedure of installing isolating transformers to solve the problem, therefore, offers no help if direct-current service is involved.

Probably the most sensible solution in these cases, would be to bring in from the public service company an alternating current line to serve the surgical area. Where this does not provide an acceptable solution, another alternative would be to add a motor generator set to the circuit so that the direct-current supply can be transformed to alternating current. A third method would be to install a suitable battery arrangement.

Testing Ground Detectors

Provisions should be made to test the ground detector at least once a month to make sure it is functioning properly. The test, which should be made in each operating room, can be done very simply with the typical lamp device used by electrical maintenance men for testing circuits.

The test device usually consists of two metallic probes, with insulated handles, each of which is connected to one side of an electric lamp. When each of the probes is inserted into the proper part of a wall receptacle, the lamp should light but no signal should come from the ground detector. When one probe is inserted into the receptacle connected to the wiring system and the other probe is inserted in the contact connected to the grounding wire,

however, the detector signal should indicate the ground by the red light and the buzzer. The ground detector also should change to red and the buzzer should sound if one of the probes is inserted into the portion of the receptacle connected to the wiring system and the other probe touches the receptacle face plate or any other metal part of the electrical system connected to the conduit system (which in the case of a nonmetallic face plate might be a screw which attaches the face plate to the junction box). Records of these tests should be kept, indicating who conducted them.

While it is not required that the conductive floor be connected to an earth ground, it is almost inconceivable that there would not be some connection to earth ground.

Appliance Cords

This discussion has dealt almost entirely with the isolated ungrounded wiring system because it appears to be one of the least understood aspects of the National Fire Protection Association recommendations. Another protection against shock is achieved, however, by connecting electrical apparatus introduced into the anesthetizing location to the wall receptacles by the three-wire cord.

This is important because when the grounding wire is properly attached, a defect within the appliance will immediately register on the ground detector. This not only protects personnel against shock, but it also indicates the possibility of a spark hazard which might be close enough to the zone containing a flammable anesthetic mixture to ignite that mixture.

For details about the flexible cord approved for anesthetizing locations, Section 5-17 of the NFPA Pamphlet No. 56 should be consulted. This section calls for a flexible cord which is continuous, does not have switches interposed between the appliance and the attachment plug, and is a type designated for extra hard usage in accordance with Section 5021 of the National Electrical Code. The correct length of the cord is also quite important, and Pamphlet No. 56 says "the flexible cord shall be of sufficient length to reach any position in which the portable device is to be used."

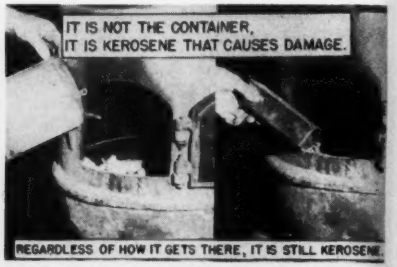
In order to prevent having a snake's nest of electrical cords on the operating room floor, it is recommended that all portable equipment be provided with some kind of electrical storage device on which the cord can be wound, in such a manner that it will not bend more sharply than a circle with a three inch radius.

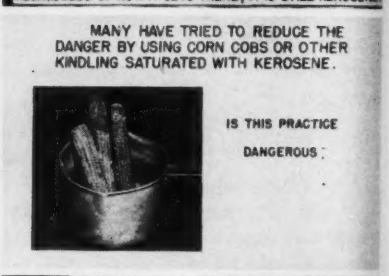
To prevent undetected, accidental breakage within the flexible cord, the recommendations suggest using a cord which consists of two insulated conductors surrounded by, but insulated from, a braided wire. This surrounding braided wire should be connected to the ground terminal of the wall outlet and to the outside metallic shell of the electrical appliance.

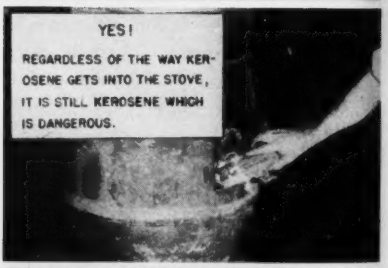
Generally, the recommendations continue to require approved explosion-proof electrical receptacles and switches for installations below the five-foot level in the operating rooms of newly-constructed hospitals. For installation in existing buildings, they still suggest using replacement units which are in themselves explosion-proof and do not require alterations in the conduit system to comply with National Electrical Code requirements.

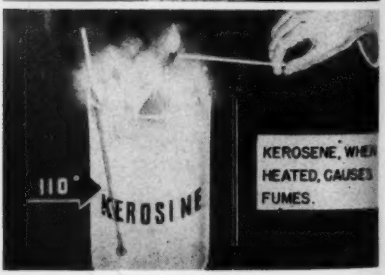
Kerosene Kindling Kills

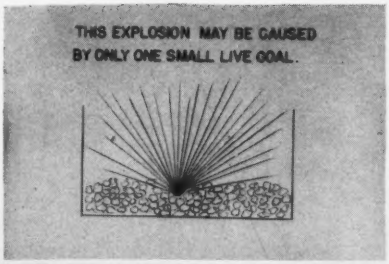
A Photographic Essay Based on a Slidefilm Produced by Ohio Farm and Home Safety Committee in Co-operation with the Ohio State Fire Marshal

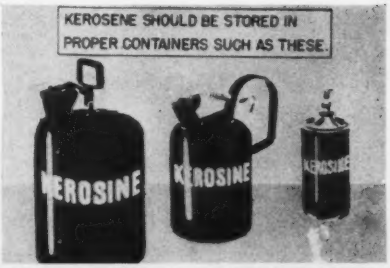


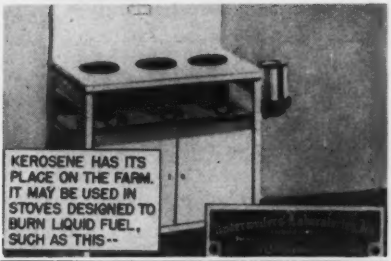

MANY HAVE TRIED TO REDUCE THE DANGER BY USING CORN COBS OR OTHER KINDLING SATURATED WITH KEROSENE.
IS THIS PRACTICE DANGEROUS?











Memphis Fire Department Safety Hints on Use of Kerosene

1. Never use kerosene to start any fire.

2. Follow the manufacturer's operating instructions for your oil-burning cooking or heating device. Post instruction card near stove.

3. Burners should be kept clean at all times. Fires are caused by stopped-up burners.

4. When wicks are burned low, they should be trimmed or replaced with new wicks.

5. Use ONLY recommended fuel. Fuel should be free of any foreign matter.

6. Kerosene cooking stoves should be provided with a drip pan beneath the burners, with legs of proper height for ordinary use.

7. Use any APPROVED-TYPE stove. All approved-type stoves bear the label of the Underwriters' Laboratories (UL).

8. A leveling device should be used to see that all cooking and heating devices are level.

9. Supply tanks should be filled on the outside of the building, using a funnel to avoid spillage. Supply tanks should be cleansed of any kerosene on the outside before replacing in the stove. Close all valves before refilling.

10. Stoves should be located so that curtains or drapes will not be blown into contact with heated surfaces or open flame. No combustible (burnable) material should be stored near stove.

11. Only limited amounts of kerosene should be stored in the home.

12. Never leave your lighted stove unattended! If you leave the house, turn stove off.

LP-Gas Fires, Mattoon, Illinois

On January 27 a series of fires and explosions caused by ignition of liquefied petroleum gas that had leaked from a buried 500-gal. tank caused damage of varying degree to 16 buildings in a two-block mercantile area of Mattoon, Illinois. Because of the fortunate time of occurrence when all stores were closed (Sunday) there were no fatalities and only one serious injury. Property damage was approximately $250,000. This loss can be attributed to the absence of regulations in Mattoon to cover LP-Gas installations. Had regulations been enacted and enforced, proper testing of the storage system after installation would have revealed a defect in the installation.

Based upon reports submitted by the Mattoon Fire Department and the Illinois Inspection Bureau.

A 500-gal. capacity tank had recently been installed with auxiliary devices and piping beneath a small parking area 10 feet from the rear of the City Drug Store (No. 2 on diagram), and adjacent to a rear alley. The system was designed to replace automatically the city gas supply when outside temperatures dropped below 20°F. On January 24 an initial supply of 420 gals. of LP-Gas had been delivered, but the system had not been used prior to the fire and the tank valve was shut off.

Fires and Explosions

At about 1:00 P.M., January 27, two men saw a large fire coming from the ground at the rear of the drug store and telephoned the fire department. Response was prompt but by the time two 2½-in.

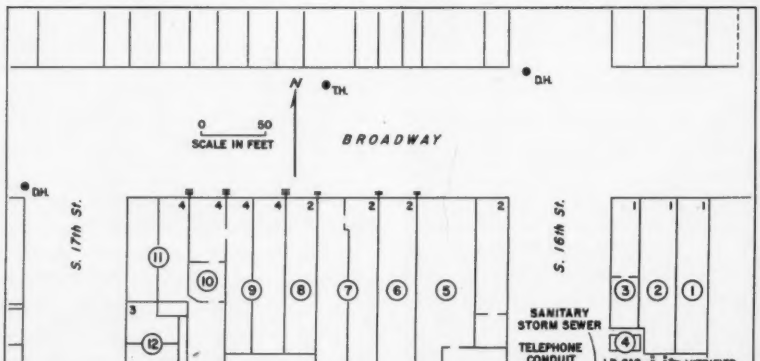


Diagram of Fire Area.

Acme

LP-Gas that had escaped from the buried 500-gal. tank at the rear of the City Drug Store is shown burning at ground level above the tank.

hose lines were laid, a wood pole carrying a transformer and power lines, and the interior of the rear of the drug store were on fire. Soon thereafter power lines running west from the burning pole above the alley to the rear of Byers Hotel (No. 10) dropped to the ground and at about the same time a fire was reported in the rear of the Harris Furniture Store (No. 7). Several minutes later the rear of No. 9 burst in flames, and a violent explosion occurred in the southeast corner of the basement of the Byers Hotel (No. 10). Since the thirty guests had previously been removed from the building, the only injury occurred to a barber in his shop in the hotel. Other fires and light explosions occurred in the buildings numbered on the diagram. Fire fighting operations continued for two hours by the Mattoon Fire Department aided by men and equipment from Arcola, Arthur, Charleston and Humboldt. Severe damage occurred in buildings No. 2 and 7, moderate damage in buildings 8, 9, 10 and 11 and slight damage to the other buildings.

Investigation of the Cause

When the LP-Gas storage tank was dug up three days later a ¾-inch threaded opening, not equipped with a plug, was found in the bottom of the tank through which the LP-Gas had undoubtedly escaped into the surrounding earth. Investigation of the tank excavation revealed parts of a former drainage system of vitrified tiles passing between the rear of building No. 2 and the alley. It was also discovered that a 12-inch city storm sewer, a telephone line conduit tunnel and an abandoned central steam line boxing extended east and west through the alley.

Results of a fluorescein dye tracing flow test on water in the storm sewer indicated the probability that gas escaping from the tank followed the vitrified drainage system to the storm sewer, flowed through the sewer and entered the various buildings along the alley through sewer connections. Since there were also several connections to these buildings from the steam boxing and telephone conduit, spread through these systems is also a possibility.

Ample ignition sources were available to ignite the gas that collected in and outside the buildings. The first fire probably occurred when gas followed the gas service line into the drug store to a gas pilot light; when the gas ignited, fire flashed back to the gas in the vicinity of the tank. The falling electric wires and coal-fired furnaces were possible ignition sources for the fires and explosions that followed. There is no obvious explanation for the delay of three days between the filling of the tank and the fires.

Cincinnati Sash and Door Co. Fire

A fire at the Cincinnati Sash and Door Co. plant on January 29, 1952 furnished a $700,000 lesson in fire protection. The simple facts of this case were that the construction of the building and hazard of occupancy of the property were such that even the best of fire departments could not be expected to extinguish a fire in this property once it was well under way. In this case an automatic fire detection system, central station connected, had been provided to call the fire department immediately in case of fire.

The fire department responded as quickly as possible but when firemen entered the basement with a hose stream, fire flashed over sawdust-covered beams to involve the entire area. Floor cracks and blocked open fire doors allowed spread to upper stories.

Construction

The fire originated in and destroyed the 4-story brick building at 946-950 W. Sixth Street and destroyed the roof and top story of the adjoining 5-story building at 942-944 W. Sixth Street with heavy water damage on lower floors. Walls of the 10,000 sq. ft. 4-story building of origin were brick with foundation walls of heavy stone arch; floors for the most part were 2½-inch plank with one-inch overlay on 12 in. by 16 in. wood beams on steel girders and columns. (Apparently flood damage had warped some of the floor planking.) Vertical shafts were enclosed with metal lath and plaster with standard fire door protection at openings.

The building was used primarily for woodworking and stock storage. The basement, where the fire originated, housed a stoker-fed heating boiler and was also used for glass storage and occasional sawing and molding.

The adjoining 5-story building of approximately 5,000 sq. ft. floor area was of similar construction and was separated from the building of origin by a parapeted fire wall with all openings protected by standard fire doors on both sides of the wall. This building was also occupied by the Cincinnati Sash and Door Company and was used for storage of sash and door stock, and for offices.

Fire Protection

Private fire protection consisted of a central-station-supervised automatic fire detection system, a manual fire alarm system and soda-acid extinguishers. There was no watchman protection and no sprinklers.

Based upon reports submitted by the Cincinnati Fire Department and the Ohio Inspection Bureau.

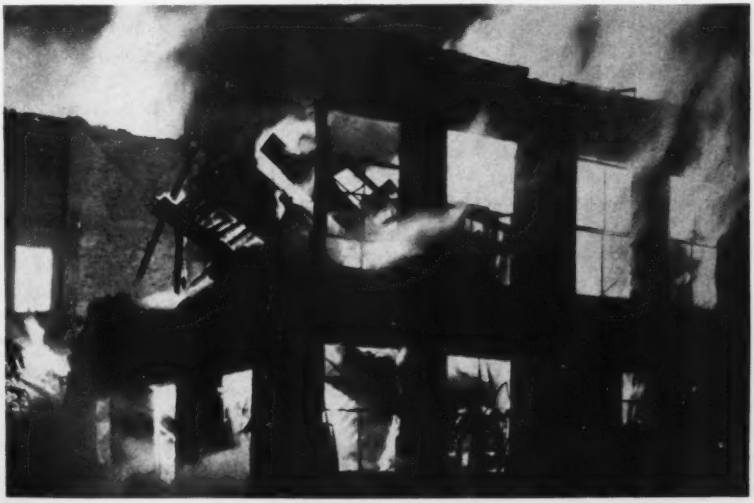
The Fire

At 5:15 P.M., 15 minutes after employees had checked out for the night in the building of origin, the central-station-supervised automatic fire detection system was actuated by a fire in the basement that originated in the vicinity of the heating boiler. Although the cause could not be determined with certainty, fire officials believe that heat escaping from a mortar opening in the chimney ignited combustible materials near the furnace.

On arrival of the first engine company, the basement and first story were charged with smoke. When the basement was entered fire flashed throughout. A second alarm was struck at 5:18 P.M. and third at 5:33 P.M. Initial attack was by hose streams through a fire wall opening from the basement of the adjoining building, and with a cellar nozzle directed through a cellar window. The effectiveness of the cellar nozzle was probably reduced by the heavy stone arch construction, and when the fire flashed throughout the basement firemen were unable to hold their position at the fire wall opening and after closing the fire door left the building and continued the attack from the first story.

Fire by then had spread to the first story through cracks in the floor and since fire doors on the stairs were blocked open, flames soon spread to upper stories where a large amount of fuel was present in the form of wood sash stock.

The intervening fire wall with all openings protected prevented spread to the 5-story exposure until flames broke through the roof. Then sparks and burning embers were carried by a 15 mph wind over the parapeted wall and ignited the tar and gravel roof covering of the adjoining building. The roof and top story of this structure were destroyed, and because high piling of stock prevented the use of salvage covers beneath the fire, water damage to stock on lower floors was heavy.



This fire in Cincinnati originated in the basement. Lack of sprinklers, cracks in warped floors, and blocked open fire doors on vertical shafts allowed spread to upper stories.

Fire Record of Cities, 1951

As Reported by Municipal Authorities

The following tables summarize the fire experience for 1951 in cities with population over 20,000 in the United States and Canada. Of the 694 cities canvassed, 634 reported.

These statistics have been collected and published in the April QUARTERLIES since 1939 and represent a permanent reference for members who desire to determine fire experience trends within a particular city by comparing present with past experience. It is not intended that these tables be the basis of comparisons among different cities, as comparisons based on these statistics may be misleading.

Fire departments of 518 United States cities and 49 Canadian cities of over 20,000 population have reported their estimates of fire loss, fire alarms, building fires, and false alarms for 1951 to the NFPA Department of Fire Record.

A total of 550 United States cities having more than 20,000 population reported a fire loss for the year 1951 of $200,746,911. Fifty-four Canadian cities having a total population of 5,142,821 reported a total loss of $21,300,822 for 1951.

The average loss per person in the 550 U. S. cities reporting losses was $3.32, 12 per cent less than the $3.79 average loss in 1950. The per capita loss in the 54 Canadian cities reporting loss figures was $4.15, an 8 per cent decrease from 1950.

The average loss per building fire in 483 U. S. cities for 1951 was $850, compared with $580 in 1950. The average loss per building fire for 45 Canadian cities was $1,320 in 1951, compared with $984 in 1950.

The total number of building fires reported by 548 U. S. cities was 243,910, an average of 4.08 fires per 1,000 population, as compared with 4.15 building fires per 1,000 population in 1950 and 4.20 in 1949. Fifty Canadian cities reported 17,186 building fires in 1951. The number per 1,000 population was 3.42 in 1951 as compared with 4.30 in 1950.

Automobile fires (including trucks) reported by 539 U. S. cities totaled 73,017, an average of 1.25 fires per 1,000 population. Forty-eight Canadian cities reported 2,839 automobile fires, an average of 0.58 per 1,000 population.

Fire departments in 558 U. S. cities of more than 20,000 population answered 743,749 alarms in 1951. The number of alarms answered in 54 Canadian cities was 53,446.

In the United States, 535 cities of over 20,000 reported 55,298 false alarms in 1951. This was 7.5 per cent of the total calls answered. It will be noted that these are "malicious false alarms" and not just cases where smoke or steam, etc., was honestly mistaken for fire. Forty-nine Canadian cities reported 6,781 malicious false alarms, or 12.7 per cent of their total calls.

Fire departments have been very cooperative in furnishing fire loss figures. Most of the 60 nonreporting cities did not record their fire experience. In a number of cases loss figures reported are preliminary estimates.

While there are occasional discrepancies in the manner in which certain cities report losses, our questionnaire calls for the total fire loss, both insured and uninsured, and this is the figure given unless otherwise indicated. Chimney and roof fires have been included in the number of building fires. A few cities do not give a complete record, but on the whole it is believed that these figures present a reliable indication of the relative trends in city fire losses.

1951 FIRE LOSSES, CITIES OF 20,000 POPULATION AND OVER

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
ALABAMA							
Anniston	31,150	58,581	396	139	63	20	4.5
Bessemer	28,471	124,795	173	60	26	2	2.1
Birmingham	298,720	1,620,848	4,463	...	386	341	..
Dothan City	21,556	44,366	433	186	41	5	8.6
Florence	23,832	30,000a	225	225	...	...	3.9
Gadsden	55,528	149,181	788	216	62	59	3.9
Mobile	127,151	260,213c	1,381	686	148	89	5.4
Montgomery	195,098	592,449c	1,144	530	102	73	2.7
Phenix City	23,285	.....	...	...	...	...	..
Selma	22,629	40,748	232	130	40	1	5.7
Tuscaloosa	46,364	34,201	394	147	61	31	3.2
ARIZONA							
Phoenix	105,042	440,468c	1,163	447	184	80	4.3
Tucson	45,064	63,389	706	170	74	64	3.8
ARKANSAS							
El Dorado	23,047	56,756	330	141	38	8	6.1
Fort Smith	47,864	115,759	1,264	313	69	25	6.5
Hot Springs	29,298	65,761	351	...	43	15	..
Little Rock	101,387	459,944	2,068	703	...	3	6.9
North Little Rock	42,142	238,530	1,109	281	84	13	6.7
Pine Bluff	37,147	72,706b	774	308	73	11	8.3
CALIFORNIA							
Alameda	63,425	132,865	816	203	77	77	3.2
Alhambra	51,284	69,765	373	89	48	47	1.7
Arcadia	23,041	45,084	192	26	16	7	1.1
Bakersfield	34,540	309,164	979	204	138	74	5.9
Belvedere	37,192	.....	...	...	...	...	..
Berkeley	113,217	130,343	1,742	426	107	61	3.8
Beverly Hills	30,000	239,552	378	120	56	17	4.0
Burbank	78,318	395,587	976	265	112	10	3.4
Compton	47,893	236,048	542	126	63	2	2.6
Eureka	22,913	116,620	191	8	14	8	.4
Fresno	90,618	259,104	769	197	112	60	2.2
Glendale	95,398	93,130	907	270	110	66	2.8
Huntington Park	29,376	73,740c	198	58	35	12	2.0
Inglewood	46,046	194,634	374	147	80	7	3.2
Long Beach	244,072	553,958	1,839	423	250	68	1.7
Los Angeles	1,957,692	2,655,331a	23,591	13,166	2,500	1,613	6.7
Lynwood	25,534	398,794	128	64	...	15	2.5
Monrovia	20,274	19,044	342	55	30	5	2.7
Montebello	21,754	16,047c	248	56	27	0	2.6
Monterey Park	20,113	20,023	138	59	21	15	2.9
National City	21,132	28,950	202	89	5	1	4.2
Oakland	380,576	1,555,888c	4,900	601	486	547	1.6
Ontario	22,823	25,725	149	44	28	13	1.9
Oxnard	21,159	159,328	155	75	34	1	3.5
Palo Alto	25,290	47,875	441	49	41	30	1.9
Pasadena	104,085	53,635	1,033	391	134	93	3.8
Pomona	35,157	16,780	554	92	59	4	2.6
Redondo Beach	25,208	12,176	296	69	52	10	2.7
Redwood City	25,342	565,185	491	85	48	27	3.4
Richmond	99,218	152,736	1,615	426	107	49	4.3
Riverside	46,399	56,634	500	145	59	22	3.1

a. Estimated. b. Insured loss. c. Building and contents.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
CALIFORNIA (Continued)							
Sacramento	135,761	287,928a, c	1,157	487	215	129	3.6
San Bernardino	62,792	144,214c	674	186	96	41	3.0
San Diego	321,485	542,996c	3,195	1,141	415	152	3.6
San Francisco	760,753	.....	...	...	...	...	..
San Gabriel	20,204	16,038	171	25	22	2	1.2
San Jose	95,044	282,512c	1,148	205	83	41	2.2
San Leandro	27,498	85,352	333	137	28	6	5.0
San Mateo	41,536	71,202c	543	98	43	8	2.4
Santa Ana	45,534	37,558c	468	135	70	21	3.0
Santa Barbara	44,764	25,732c	663	158	59	38	3.5
Santa Cruz	21,848	62,510	277	79	32	16	3.6
Santa Monica	71,299	275,841	1,030	298	116	49	4.2
South Gate	50,684	164,072	684	212	...	10	4.2
Stockton	71,660	205,476c	1,541	348	171	76	4.9
Torrance	22,206	17,482	277	69	45	0	3.1
Vallejo	23,164	69,287	982	235	94	117	10.2
Whittier	23,866	16,079	218	61	39	0	2.6
COLORADO							
Colorado Springs	45,268	45,982	539	211	46	37	4.7
Denver	412,856	.....	...	...	...	...	..
Greeley	21,000	48,675c	197	96	26	13	4.6
Pueblo	63,561	75,261	2,788	365	147	26	5.8
CONNECTICUT							
Bridgeport	159,352	.....	1,616	661	330	80	4.2
Bristol	35,893	140,788c	380	136	47	14	3.8
Danbury	22,424	133,236	392	210	42	8	9.4
East Hartford	29,340	15,343c	385	102	54	6	3.5
Fairfield	30,370	20,095	266	25	24	...	.8
Greenwich	40,546	.....	...	...	...	...	..
Hamden	29,311	15,760	544	28	45	29	.9
Hartford	177,073	359,836c	2,270	867	310	159	4.9
Manchester	33,906	.....	...	...	...	...	..
Meriden	43,747	102,998	489	168	63	20	3.8
Middletown	29,665	257,262a	185	44	35	11	1.5
Milford	26,345	176,893	500	127	48	15	4.8
New Britain	73,663	134,473	796	194	61	28	2.6
New Haven	163,344	540,812	2,694	783	219	167	4.8
New London	30,367	96,125	635	182	68	25	6.0
Norwalk	49,458	148,575	618	212	72	25	4.3
Norwich	23,382	175,151	331	158	37	12	6.8
Stamford	73,584	286,974	696	136	86	77	3.3
Stratford	23,620	95,685	613	77	43	44	3.3
Torrington	27,770	108,462d	266	85	31	11	3.1
Waterbury	104,242	243,673	1,390	398	117	66	3.8
West Hartford	44,401	24,038	444	153	40	11	3.4
West Haven Twp.	31,876	.....	...	...	...	...	..
DELAWARE							
Wilmington	109,907	252,088	1,282	731	173	61	6.7
DISTRICT OF COLUMBIA							
Washington, D. C.	797,670	1,931,130	10,263	2,961	817	1,141	3.7
FLORIDA							
Daytona Beach	29,254	80,939	467	146	31	8	5.0
Fort Lauderdale	40,000	77,838	537	128	39	24	3.2
Gainesville	26,577	.....	...	...	...	...	..
Jacksonville	198,800	637,316	2,795	725	183	158	3.7

a. Estimated. c. Building and contents. d. Incomplete.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
FLORIDA (Continued)							
Key West	21,724	5,510	206	...	18	...	..
Lakeland	30,846	25,890	413	140	38	31	4.6
Miami	246,983	501,396	3,212	553	150	204	2.2
Miami Beach	45,541	.....	...	...	...	...	..
Orlando	51,826	212,130	582	78	37	56	1.5
Panama	26,248	53,634	452	109	16	11	4.2
Pensacola	43,293	95,762	493	225	50	22	5.2
St. Petersburg	95,712	137,781	1,500	159	119	3	1.7
Tallahassee	27,158	101,854	502	67	41	8	2.5
Tampa	124,073	1,154,467	1,530	429	124	179	3.5
West Palm Beach	43,053	95,532	270	57	...	5	1.3
GEORGIA							
Albany	30,987	43,465	605	319	99	24	10.3
Athens	20,102	61,447	397	24	49	18	1.2
Atlanta	327,090	678,209	5,926	1,493	409	210	4.6
Augusta	71,507	.....	...	...	...	...	..
Columbus	79,510	291,238c	753	437	102	42	5.5
Decatur	21,626	121,124	209	61	13	4	2.8
East Point	21,628	.....	...	...	...	...	..
La Grange	24,954	201,324	419	177	73	12	7.1
Macon	70,106	209,151	670	352	93	48	5.0
Marietta	20,628	18,876	284	100	25	2	4.8
Rome	29,617	88,091	508	49	...	8	1.7
Savannah	119,689	130,425	1,612	1,021	168	95	8.5
Valdosta	20,004	130,706	321	...	...	...	..
IDAHO							
Boise	34,152	1,174,809c	583	95	24	40	2.8
Pocatello	25,882	21,355c	295	141	21	32	5.5
ILLINOIS							
Alton	32,176	189,100	455	205	78	6	6.4
Aurora	50,508	414,318	569	297	70	13	5.9
Belleville	32,701	86,938	445	160	57	...	4.9
Berwyn	51,176	61,045	380	88	35	10	1.7
Bloomington	34,048	105,612c	528	159	59	19	4.7
Champaign	39,397	286,000	341	215	26	30	5.5
Chicago	3,606,436	9,600,000	38,131	12,854	4,844	3,507	3.6
Chicago Heights	24,369	833,275	186	98	36	12	4.0
Cicero	67,197	67,800	803	182	66	70	2.7
Danville	37,892	.....	...	...	...	...	..
Decatur	67,803	210,833	548	292	111	15	4.3
East St. Louis	81,950	186,209	1,266	576	130	114	7.1
Elgin	42,003	44,846	374	78	50	16	1.9
Elmhurst	21,204	10,115c	141	23	27	8	1.1
Evanston	73,030	135,877	622	280	63	47	3.8
Freeport	22,425	164,553	324	28	3	28	1.3
Galesburg	31,357	23,925	306	55	45	7	1.8
Granite City	29,139	.....	...	...	...	...	..
Harvey	20,636	8,060	330	89	54	9	4.3
Jacksonville	20,374	48,389	236	80	29	0	3.9
Joliet	52,460	97,605	858	466	89	27	8.9
Kankakee	25,873	50,490	498	71	8	10	2.8
Maywood	27,409	18,990	341	176	43	0	6.4
Moline	37,296	.....	...	...	...	...	..
Oak Park	63,175	60,404	989	220	70	4	3.5
Pekin	21,912	61,618	210	66	31	0	3.0
Peoria	111,523	919,933	1,375	732	171	108	6.6
Quincy	41,402	56,240c	662	200	82	24	4.8

c. Building and contents.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
ILLINOIS (Continued)							
Rockford	92,503	194,978	1,116	483	155	3	5.2
Rock Island	48,594	114,448	533	124	75	10	2.6
Springfield	80,832	492,885	967	...	...	...	..
Urbana	22,995	12,466	205	44	19	6	1.9
Waukegan	39,099	41,074	622	198	61	17	5.1
INDIANA							
Anderson	46,809	308,132	698	446	64	33	9.5
Bloomington	28,191	46,780	463	177	62	8	6.3
East Chicago	54,124	99,615	1,221	123	90	...	2.3
Elkhart	35,556	76,565	816	404	55	42	11.4
Evansville	109,869	1,725,100	1,756	732	210	70	6.7
Fort Wayne	132,840	471,621	2,053	940	220	107	7.1
Gary	132,496	.....	...	...	...	...	..
Hammond	87,423	55,461	1,736	387	166	71	4.4
Indianapolis	424,683	851,536	4,884	2,205	702	295	5.2
Kokomo	38,600	147,923	454	269	72	35	7.0
Lafayette	35,508	1,754,500	510	253	103	18	7.1
Logansport	20,933	26,506	526	249	58	25	11.9
Marion	30,059	555,904	492	316	70	22	10.4
Michigan City	28,379	28,674	423	187	59	15	6.7
Mishawaka	32,878	39,499	497	163	51	31	5.0
Muncie	58,364	314,280	902	428	124	41	7.4
New Albany	29,297	262,255	433	265	56	33	9.1
Richmond	39,504	392,625c	531	260	76	22	6.6
South Bend	115,698	382,410	1,549	754	174	138	6.5
Terre Haute	64,047	188,190	1,299	632	101	18	9.9
IOWA							
Ames	23,105	28,368	...	137	...	...	5.9
Burlington	30,639	264,147	481	184	63	3	6.0
Cedar Rapids	72,149	465,491	817	464	114	39	6.4
Clinton	30,151	45,174	692	198	49	3	6.6
Council Bluffs	45,184	71,854	588	197	94	31	4.4
Davenport	73,640	319,394	907	198	118	52	2.7
Des Moines	176,954	714,437	2,307	661	266	84	3.8
Dubuque	49,528	59,228	869	317	104	17	6.4
Fort Dodge	25,025	21,910	240	80	40	19	3.2
Iowa City	27,018	71,549	243	176	30	3	6.5
Mason City	27,593	13,646	395	77	43	0	2.8
Ottumwa	33,640	179,846	751	189	83	1	5.6
Sioux City	84,035	348,013	910	517	116	42	6.2
Waterloo	64,354	93,481	1,018	370	149	106	5.8
KANSAS							
Hutchinson	33,524	48,066	589	178	80	2	5.3
Kansas City	129,583	495,422	2,069	720	149	92	5.6
Lawrence	23,292	23,586	285	...	...	...	..
Leavenworth	20,543	57,358	390	128	32	6	6.2
Salina	26,141	36,366	446	175	79	15	6.7
Topeka	77,827	231,280	1,141	266	120	98	3.4
Wichita	166,306	379,408	2,843	635	296	61	3.8
KENTUCKY							
Ashland	31,228	.....	...	...	...	...	..
Covington	64,282	19,213	1,920	232	94	29	3.6
Lexington	54,449	502,576	635	321	91	97	5.9
Louisville	367,359	342,172	4,113	2,113	589	173	5.8
Newport	31,013	15,748	321	205	68	22	6.6
Owensboro	33,983	96,172	594	...	59	25	..
Paducah	32,430	64,769	1,032	334	86	30	10.3

c. Building and contents.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
LOUISIANA							
Alexandria	34,685	214,430	386	200	50	31	5.8
Baton Rouge	123,957	324,332	1,380	571	42	78	4.6
Lafayette	33,465	222,685	332	151	46	6	4.5
Lake Charles	41,202	.....	...	...	...	...	..
Monroe	38,375	443,074	869	265	90	33	6.9
New Orleans	567,257	1,425,537	5,240	1,755	227	283	3.1
Shreveport	125,506	534,622	1,604	549	148	89	4.4
MAINE							
Auburn	23,078	50,000a	403	94	43	5	4.1
Augusta	20,900	17,759	268	160	35	2	7.7
Bangor	31,473	180,835	638	417	61	65	13.3
Biddeford	20,700	91,377	364	299	19	2	14.3
Lewiston	41,142	144,348	833	401	30	...	9.8
Portland	76,936	51,187c	1,277	146	...	100	1.9
South Portland	21,732	25,282	343	125	17	34	5.8
MARYLAND							
Baltimore	940,205	8,917,021	12,374	5,447	1,258	871	5.8
Cumberland	37,632	.....	479	318	91	40	8.5
Hagerstown	36,232	.....	...	...	...	...	..
Montgomery County	163,749	619,471	1,509	650	182	...	4.0
MASSACHUSETTS							
Arlington	43,984	111,636	850	...	82	34	..
Attleboro	23,665	15,056	505	115	50	19	4.9
Belmont	27,379	.....	...	...	...	...	..
Beverly	28,855	30,890	757	182	55	13	6.3
Boston	790,863	.....	15,234	3,914	1,077	2,310	4.9
Braintree	23,130	29,639c	621	558	47	...	24.2
Brockton	62,856	227,410	1,695	588	108	104	8.9
Brookline	56,952	.....	...	...	...	...	..
Cambridge	120,676	349,970c	2,247	686	176	351	5.7
Chelsea	39,038	139,148	1,164	154	41	108	5.3
Chicopee	48,939	90,839	671	159	48	30	3.3
Everett	45,789	111,793c	900	202	94	106	4.4
Fall River	111,759	205,590a, c	1,219	409	116	97	3.7
Fitchburg	42,671	90,099a, c	783	207	43	28	4.9
Framingham	27,845	.....	...	...	...	...	..
Gloucester	25,048	119,299a	685	183	29	29	7.3
Haverhill	47,213	215,072c	1,234	295	112	107	6.3
Holyoke	54,441	.....	...	...	...	...	..
Lawrence	80,427	800,000a, c	1,605	276	99	108	3.4
Leominster	24,084	.....	...	...	...	...	..
Lowell	96,523	126,614	1,621	518	120	62	5.4
Lynn	99,521	314,729c	2,351	606	141	201	6.1
Malden	59,779	84,592a	1,027	77	57	40	1.3
Medford	66,109	111,796b	1,098	240	139	94	3.6
Melrose	26,919	28,675	559	31	26	6	1.2
Methuen	24,411	106,033	489	124	40	18	5.1
Milton	22,395	35,670	583	69	70	66	3.1
New Bedford	109,033	264,360	876	182	98	59	1.7
Newton	80,996	149,199	1,535	207	87	59	2.6
North Adams	21,475	30,540	378	237	40	10	11.1
Northampton	28,998	17,275	367	171	34	16	5.9
Peabody	22,647	145,400	516	136	43	18	6.0
Pittsfield	53,055	115,680d	793	271	98	41	5.1
Quincy	83,190	221,716c	1,895	340	116	162	4.1
Revere	36,663	102,644	1,031	91	73	158	2.5
Salem	41,842	324,681c	887	243	91	18	5.8

a. Estimated. b. Insured loss only. c. Building and contents. d. Incomplete.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
MASSACHUSETTS (Continued)							
Somerville	102,254	459,191	2,022	612	127	273	6.0
Springfield	162,601	545,567	2,671	552	201	285	3.4
Taunton	40,056	38,236	634	186	52	25	4.7
Waltham	47,198	118,982	891	121	57	52	2.6
Watertown	37,339	81,840	938	41	2	44	1.1
Wellesley	20,847	43,989	408	31	58	17	1.4
Westfield	20,961	34,054	547	126	29	2	6.0
West Springfield	20,398	27,290	361	67	32	16	3.3
Weymouth	32,695	78,901	687	114	63	20	3.5
Woburn	20,269	27,716	749	32	26	86	1.6
Worcester	201,885	929,000a	4,091	...	...	...	..
MICHIGAN							
Ann Arbor	47,279	142,079	492	58	69	10	1.2
Battle Creek	48,469	504,006	896	213	93	79	4.4
Bay City	52,372	106,250	828	251	65	13	4.8
Dearborn	94,529	203,400	1,741	295	118	147	3.1
Detroit	1,838,517	5,189,243a,c	16,245	5,849	2,207	...	3.2
East Detroit	21,373	137,160	183	89	28	5	4.2
East Lansing	20,310	21,808	140	13	18	3	.6
Ferndale	29,670	36,100	362	128	63	41	4.3
Flint	162,800	745,281	1,841	839	212	165	5.2
Grand Rapids	175,647	586,521	1,448	302	108	75	1.7
Hamtramck	43,245	138,509	642	419	31	42	9.7
Highland Park	46,155	85,990	750	257	83	30	5.6
Jackson	50,904	86,223	882	577	95	42	11.3
Kalamazoo	51,326	209,030c	658	140	135	23	2.7
Lansing	91,694	1,590,333c	2,067	325	171	102	3.5
Lincoln Park	29,265	49,370	378	103	37	48	3.5
Monroe	21,275	69,607	253	110	28	17	5.2
Muskegon	48,047	79,388	768	240	88	47	5.2
Pontiac	73,112	305,223	1,117	324	111	127	3.4
Port Huron	35,297	247,050c	605	195	61	17	5.5
River Rouge	20,366	88,922	177	91	41	17	4.5
Royal Oak	46,817	.....	...	...	...	...	..
Saginaw	92,352	924,366c	1,273	279	...	31	3.0
Wyandotte	36,666	154,544	516	118	49	45	3.2
MINNESOTA							
Austin	23,035	26,801c	119	75	16	13	3.3
Duluth	104,066	671,096	1,326	224	81	56	2.2
Minneapolis	517,277	2,001,769	4,470	1,076	450	259	2.1
Rochester	29,634	12,000	392	114	40	82	3.9
St. Cloud	22,744	40,195	218	158	15	3	7.0
St. Louis Park	22,495	142,600	270	106	31	4	4.7
St. Paul	309,474	1,935,202a	3,721	703	380	362	2.3
Winona	24,965	14,036	288	113	26	25	4.5
MISSISSIPPI							
Biloxi	37,034	140,868	309	108	53	9	2.9
Greenville	29,914	40,340c	482	260	56	11	8.7
Gulfport	22,428	.....	...	...	...	...	..
Hattiesburg	29,432	45,952	510	...	45	...	..
Jackson	97,674	131,430	1,027	419	115	51	4.3
Laurel	24,988	.....	...	...	...	...	..
Meridian	41,709	70,624	657	283	66	42	6.8
Natchez	22,678	.....	...	...	...	...	..
Vicksburg	27,344	88,900	...	...	...	13	..

a. Estimated. c. Building and contents.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
MISSOURI							
Cape Giradeau	21,539	205,256	311	155	40	6	7.2
Columbia	31,731	128,596	490	210	54	8	6.6
Hannibal	20,486	67,121	278	117	49	9	5.7
Independence	36,832	82,693	707	165	58	19	4.5
Jefferson City	24,990	17,290	455	104	40	6	4.2
Joplin	37,188	127,607	1,061	360	118	25	9.7
Kansas City	439,646	3,817,708	6,294	1,890	631	452	4.3
St. Joseph	75,572	74,291	1,432	420	180	51	5.6
St. Louis	852,623	.....	9,494	3,239	...	1,168	3.8
Sedalia	20,269	36,456	388	127	46	...	6.3
Springfield	66,302	.....	...	...	...	...	..
University City	39,595	46,491	944	95	27	15	2.4
Webster Grove	23,289	27,735c	233	39	18	4	1.7
MONTANA							
Billings	31,725	353,279c	337	101	45	26	3.2
Butte	32,904	82,032	487	155	26	115	4.7
Great Falls	39,006	12,226	330	25	18	22	.6
Missoula	22,320	.....	301	77	31	18	3.4
NEBRASKA							
Grand Island	22,835	19,616	1,119	196	45	9	8.6
Hastings	20,108	25,520	279	87	34	10	4.3
Lincoln	97,423	400,000a, c	1,199	448	214	9	4.6
Omaha	247,408	1,040,958a	2,835	1,108	380	87	4.5
NEVADA							
Las Vegas	24,418	192,942	614	264	77	48	10.8
Reno	32,225	158,735	967	300	44	14	9.3
NEW HAMPSHIRE							
Concord	27,984	21,778c	546	244	71	3	8.8
Manchester	82,581	345,927c	1,049	344	89	29	4.2
Nashua	34,666	214,755c	476	259	...	8	7.5
NEW JERSEY							
Atlantic City	61,642	1,009,127	699	346	72	156	5.6
Bayonne	76,657	.....	922	204	84	75	2.7
Belleville	32,059	29,776c	473	40	...	13	1.3
Bloomfield	49,313	49,711	672	177	51	23	3.6
Camden	125,546	142,806	1,819	272	141	163	2.2
Clifton	64,567	350,709	815	113	85	12	1.8
East Orange	78,057	102,176c	780	241	79	51	3.1
Elizabeth	112,675	.....	...	...	...	...	..
Englewood	23,092	.....	...	...	...	...	..
Fair Lawn	23,865	.....	...	...	...	...	..
Garfield	27,605	.....	...	...	...	...	..
Hackensack	29,207	.....	566	85	52	18	..
Hillside	21,000	80,840	374	173	34	2	8.2
Hoboken	50,510	256,501c	876	302	71	55	6.0
Irvington	59,142	135,536	434	214	63	21	3.6
Jersey City	300,447	356,510c	3,387	1,579	368	...	5.3
Kearny	39,828	74,534	482	94	79	38	2.4
Linden	30,434	45,412c	600	85	83	21	2.8
Long Branch	23,094	.....	...	...	...	...	..
Maplewood	25,000	6,834	236	110	32	19	4.4
Montclair	43,775	109,128	565	197	87	24	4.5
Newark	437,857	2,391,350a	5,404	2,327	927	612	5.3
New Brunswick	38,768	200,847c	564	182	61	44	4.7
North Bergen Twp.	39,714	134,975	923	95	86	20	2.4
Nutley	26,746	409,224	447	83	37	35	3.1

a. Estimated. c. Building and contents.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
NEW JERSEY (Continued)							
Orange	38,413	41,940	467	191	66	41	5.0
Passaic	57,851	1,479,045	752	287	71	41	5.0
Paterson	139,423	.....	1,549	803	196	69	5.8
Perth Amboy	41,291	.....	...	...	...	...	..
Plainfield	42,212	.....	641	156	61	39	3.7
Rahway	21,287	81,930	365	96	38	8	4.5
Teaneck Twp.	34,000	32,297	741	112	40	9	3.3
Trenton	127 867	446,005	1,313	513	180	99	4 0
Union City	55,322	125,053c	1,016	275	54	47	5.0
Union Twp.	39,000	83,181	504	146	67	...	3.7
West New York	37,754	328,618	552	108	42	29	2.8
Westfield	21,335	.....	...	...	...	...	..
West Orange	28,624	24,632	349	97	61	33	3.4
NEW MEXICO							
Albuquerque	97,000	.....	...	...	...	...	..
Roswell	25,572	49,841	...	...	...	...	..
Santa Fe	29,750	41,710	163	62	38	7	2.1
NEW YORK							
Albany	134,382	.....	...	...	...	...	..
Amsterdam	32,269	36,627c	301	122	45	14	3.8
Auburn	36,667	49,646	403	154	51	33	4.2
Binghamton	81,132	791,136	718	146	86	20	1.8
Buffalo	477,393	1,455,039	5,959	1,214	354	257	2.5
Cohoes	21,235	19,811	322	271	15	7	1.3
Elmira	49,690	129,713c	502	246	46	32	4.9
Endicott	20,168	10,237c	144	43	23	7	2.1
Freeport	24,589	.....	...	...	...	...	..
Gloversville	23,576	68,245c	274	60	13	18	2.6
Hempstead	29,021	.....	...	...	...	...	..
Irondiquoit Twp.	34,045	.....	...	...	...	...	..
Ithaca	29,395	.....	...	...	...	...	..
Jamestown	43,250	117,751c	546	148	40	10	3.4
Kenmore	20,332	8,165	109	29	12	10	1.4
Kingston	28 860	108,038	463	175	45	39	6.1
Lackawana	27,646	23,709	328	34	37	47	1.2
Lockport	25,136	80,367	396	126	38	16	5.0
Middletown	22,565	28,655	262	114	42	9	5.1
Mount Vernon	71,837	105,461	881	232	62	43	3.2
Newburgh	31,924	81,530c	274	133	56	16	4.2
New Rochelle	59,626	243,605	648	257	63	33	4.3
New York	7,835,099	21,082,530c	62,728	21,531	5,847	12,011	2.7
Niagara Falls	90,875	169,760	945	249	83	70	2.7
North Tonawanda	24,730	118,785	294	127	28	5	5.1
Olean	22,842	44,273	226	35	26	9	1.5
Oswego	22,611	50,899c	261	113	...	20	5.0
Port Chester	23,969	.....	...	...	...	...	..
Poughkeepsie	40,975	.....	...	...	...	...	..
Rochester	331,252	1,172,403	3,135	821	322	132	2.5
Rockville Centre	22,274	69,410	194	33	12	8	1.5
Rome	41,379	60,332c	411	81	51	21	2.0
Schenectady	92,070	132,999	1,065	255	116	60	2.8
Syracuse	220,067	1,538,860	1,593	619	253	186	2.8
Troy	71,659	192,873c	1,157	373	99	25	5.2
Utica	101,479	425,473	840	263	81	60	2.6
Valley Stream	26,833	53,260	160	27	22	15	1.0
Watertown	34,280	37,076c	408	172	57	27	5.0
White Plains	43,501	100,000a, c	531	148	72	28	3.4
Yonkers	152,533	361,060a	2,115	544	159	92	3.6

a. Estimated. c. Building and contents.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
NORTH CAROLINA							
Asheville	52,208	303,885	907	158	76	72	3.0
Burlington	24,495	63,112	541	83	...	16	3.4
Charlotte	133,219	390,896	2,504	1,126	169	296	8.5
Durham	70,307	121,135c	996	468	125	55	6.7
Fayetteville	34,605	63,098	732	338	81	54	9.8
Gastonia	23,003	.....	...	...	...	...	..
Goldsboro	21,399	117,576	433	240	28	20	11.3
Greensboro	73,703	203,423c	1,194	361	142	110	4.9
High Point	39,930	155,996c	777	257	110	45	6.4
Raleigh	65,123	112,345	949	124	98	86	1.9
Rocky Mount	27,644	19,864c	402	226	36	11	8.2
Wilmington	44,925	109,771c	603	386	51	71	8.6
Wilson	22,964	170,800c	349	115	36	16	5.0
Winston-Salem	86,816	281,143	1,167	186	254	56	2.1
NORTH DAKOTA							
Fargo	37,981	293,331	537	...	...	...	..
Grand Forks	26,617	60,159c	261	171	27	13	6.4
Minot	21,924	53,034	228	137	35	9	6.3
OHIO							
Akron	273,189	1,423,990	2,400	674	319	256	2.5
Alliance	26,112	1,470	160	80	30	2	3.1
Ashtabula	23,093	76,115	332	84	39	7	3.7
Barberton	27,893	50,198	327	95	64	29	3.4
Canton	116,312	608,720c	1,194	261	143	148	2.2
Chillicothe	20,121	69,765	239	58	51	9	2.9
Cincinnati	500,510	993,004	5,766	2,054	743	409	4.1
Cleveland	905,636	4,283,369	9,231	2,371	902	857	2.6
Cleveland Heights	58.782	36,160	940	172	66	9	2.9
Columbus	374,770	566,800	3,945	2,296	698	117	6.1
Cuyahoga Falls	29,076	68,810	324	110	40	24	3.8
Dayton	243,108	310,551	3,264	715	345	250	2.9
East Cleveland	39,875	3,230	454	90	39	20	2.3
East Liverpool	24,072	24,197c	553	184	64	8	7.7
Elyria	30,197	180,235	252	93	44	6	3.1
Euclid	41,447	.....	...	...	...	...	..
Findlay	23,806	350,225c	243	121	47	7	5.1
Garfield Heights	21,606	.....	...	...	...	...	..
Hamilton	57,717	.....	1,115	259	109	40	4.5
Lakewood	67,878	275,570	299	74	30	46	1.1
Lancaster	24,140	50,156	525	94	66	7	3.9
Lima	49,880	152,444	652	285	75	45	5.7
Lorain	50,819	182,010	537	96	62	26	1.9
Mansfield	43,363	203,535c	508	185	94	19	4.3
Marion	33,786	105,349	406	151	58	3	4.5
Massillon	29,524	34,058c	461	110	49	14	3.7
Middletown	33,634	54,516	364	167	70	32	5.0
Newark	34,178	692,991	459	21	84	8	.6
Norwood	34,626	38,906	251	134	25	12	3.9
Parma	28,852	31,383	586	32	36	6	1.1
Portsmouth	36,663	27,233	694	117	79	15	3.2
Sandusky	29,060	39,299	740	214	49	17	7.4
Shaker Heights	27,980	158,076	374	194	38	11	6.9
Springfield	78,029	329,684	2,792	496	146	63	6.4
Steubenville	35,695	170,763	445	143	62	58	4.0
Toledo	301,358	637,581	2,801	1,005	432	...	3.3
Warren	49,674	58,692	499	128	81	31	2.6
Youngstown	167.643	414,447	1,283	368	195	102	2.2
Zanesville	40,424	90,104c	434	117	97	44	2.9

c. Building and contents.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
OKLAHOMA							
Enid	35,976	127,071	540	143	61	41	4.0
Lawton	34,527	47,597	823	249	38	5	7.2
Muskogee	37,255	185,672c	938	169	44	15	4.5
Norman	26,972	17,122	259	41	19	...	1.5
Oklahoma City	242,450	681,144	5,029	1,032	292	74	4.3
Ponca City	20,185	56,085	514	116	70	13	5.8
Shawnee	24,457	57,642c	476	67	39	7	2.7
Stillwater	20,155	59,351	342	102	35	...	5.1
Tulsa	180,586	412,038	3,641	685	211	148	3.8
OREGON							
Eugene	35,672	71,557	799	381	30	21	10.7
Portland	371,011	2,211,082	4,799	3,072	344	297	8.3
Salem	43,064	97,109	567	356	48	5	8.3
PENNSYLVANIA							
Aliquippa	26,067	11,525	164	72	32	10	2.8
Allentown	106,233	108,183c	410	153	36	20	1.4
Altoona	76,844	92,720	737	221	29	28	2.9
Bethlehem	66,027	.....	...	...	...	...	..
Butler	23,511	589,590	248	122	37	4	5.2
Chester	65,824	.....	...	...	...	...	..
Dunmore	20,302	8,900	135	18	21	16	.9
Easton	34,410	30,225c	164	96	...	7	2.8
Erie	130,125	1,230,477	1,405	291	134	61	2.2
Harrisburg	89,091	300,000d	572	361	73	32	4.1
Haverford Twp.	40,000	56,894	515	89	15	7	2.2
Hazleton	35,486	.....	...	...	...	...	..
Johnstown	62,723	.....	...	...	...	...	..
Kingston	21,061	9,250c	66	9	12	5	.4
Lancaster	63,601	72,448c	288	241	47	27	3.8
Lebanon	28,134	.....	...	...	...	...	..
McKeesport	51,223	46,515	547	272	78	51	5.3
Nanticoke	20,140	3,981	73	42	10	8	2.1
New Castle	48,563	34,875	395	224	63	26	4.6
New Kensington	25,226	15,931c	132	60	22	33	2.4
Norristown	38,143	39,757	151	...	...	...	..
Philadelphia	2,064,794	11,719,421a	21,370	5,981	1,858	3,432	2.9
Pittsburgh	673,763	1,020,000a	5,249	3,123	583	1,023	4.6
Pottstown	22,616	106,388c	298	45	40	4	2.0
Pottsville	23,642	94,788	104	43	20	4	1.8
Reading	109,062	.....	...	...	...	...	..
Scranton	124,305	707,243c	1,066	320	119	135	2.6
Sharon	26,305	118,648c	245	238	...	5	9.1
Uniontown	20,423	.....	...	...	...	...	..
Upper Darby Twp.	186,000	503,072	431	145	35	12	.8
Washington	25,898	24,620	240	143	36	15	5.5
Wilkes-Barre	76,638	182,337	499	191	67	30	2.5
Wilkinsburg	31,281	19,600	230	97	33	35	3.1
Williamsport	44,946	196,727	401	341	49	11	7.6
York	59,704	78,885c	250	143	47	31	2.4
RHODE ISLAND							
Central Falls	23,610	92,980	247	147	24	18	6.2
Cranston	55,130	54,551c	840	185	77	17	3.4
East Providence	35,791	62,866	689	90	40	36	2.5
Newport	32,090	6,764	957	194	48	4	6.1

a. Estimated. c. Building and contents. d. Incomplete.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
RHODE ISLAND (Continued)							
Pawtucket	81,180	222,895	1,248	268	98	105	3.3
Providence	274,700	997,205c	3,753	619	310	575	2.3
Warwick Twp.	43,027	.....	...	...	...	...	..
Woonsocket	50,186	.....	...	...	...	...	..
SOUTH CAROLINA							
Charleston	68,243	705,315c	910	488	58	157	7.2
Columbia	85,949	397,259c	1,269	631	163	69	7.4
Greenville	57,932	114,547	983	436	141	66	7.5
Spartanburg	36,674	70,902	610	166	81	65	4.5
SOUTH DAKOTA							
Rapid City	25,179	97,302	304	56	42	8	2.2
Sioux Falls	52,161	188,070	411	155	60	27	3.0
TENNESSEE							
Chattanooga	130,333	.....	...	...	...	...	..
Jackson	30,098	113,340	430	215	35	6	7.2
Johnson City	27,778	28,460	537	208	59	3	7.5
Knoxville	124,183	129,117c	2,066	920	641	151	7.4
Memphis	394,012	.....	...	...	...	...	..
Nashville	173,359	860,157c	2,885	906	279	156	5.2
TEXAS							
Abilene	47,102	342,253c	900	55	65	44	1.2
Amarillo	73,737	550,449c	850	164	155	84	2.2
Austin	131,964	362,437c	1,878	342	123	47	2.6
Baytown	22,927	62,000	182	58	22	10	2.5
Beaumont	93,715	160,054a	1,299	789	75	63	8.4
Brownsville	36,176	31,665c	259	69	32	21	1.9
Brownwood	20,140	25,986	414	89	54	84	4.4
Corpus Christi	108,053	296,193c	1,020	300	111	56	2.8
Dallas	432,927	2,795,353c	8,305	1,078	672	260	2.5
Denton	21,345	69,359	365	69	32	...	3.2
El Paso	130,000	200,000a, c	1,661	1,398	128	135	10.7
Fort Worth	277,047	1,248,372	6,352	1,587	531	328	5.7
Galveston	65,898	267,652	1,028	368	211	212	5.6
Harlingen	23,202	.....	...	...	...	...	..
Houston	594,321	3,167,063b	7,675	2,377	611	771	4.0
Laredo	51,694	61,208	335	77	41	5	1.5
Longview	24,445	48,346c	499	117	56	2	4.8
Lubbock	71,390	315,000	836	413	150	29	5.8
Marshall	22,255	49,900c	417	84	51	7	3.8
McAllen	20,005	.....	...	...	...	...	..
Midland	21,756	53,407c	397	157	51	15	7.2
Odessa	29,432	108,490	538	288	107	2	9.8
Orange	21,100	105,200c	394	76	34	13	3.6
Paris	21,636	106,949c	615	131	63	4	6.1
Pasadena	22,444	30,531	225	41	19	4	1.8
Port Arthur	57,377	90,643c	564	291	56	81	5.1
San Angelo	51,889	.....	...	...	...	...	..
San Antonio	406,811	1,237,864	4 982	1,344	549	124	3.3
Sherman	20,013	42,000	436	369	31	...	18.4
Temple	24,970	75,550	...	...	...	...	..
Texarkana	24,657	.....	...	...	...	...	..
Tyler	38,864	91,420c	699	211	82	13	5.5
University Park	23,823	231,994c	217	47	22	1	2.0
Waco	84,300	251,469a, c	1,102	461	196	23	5.5
Wichita Falls	67,709	147,996c	1,359	333	129	50	4.9

a. Estimated. b. Insured loss only. c. Building and contents.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
UTAH							
Ogden	56,910	79,277	1,518	186	64	60	3.3
Provo City	28,901	57,368	288	109	34	9	3.8
Salt Lake City	181,718	216,692	1,891	563	119	98	3.1
VERMONT							
Burlington	33,039	.....	546	338	64	28	10.2
VIRGINIA							
Alexandria	61,604	426,659c	680	338	144	6	5.5
Arlington County	134,990	235,261	1,429	637	205	64	4 8
Charlottesville	25,909	113,450c	355	77	39	9	3 0
Danville	34,537	218,729	546	266	61	27	7.7
Lynchburg	47,639	244,446	808	341	85	56	7.2
Newport News	41,571	154,168	748	376	64	69	9.1
Norfolk	188 601	332,919	3,472	961	202	399	5.1
Petersburg	34,948	87,964	687	382	100	47	10.9
Portsmouth	71,294	321,100	1,248	355	72	122	5.0
Richmond	229,906	1,267,137	3,840	2,255	425	216	9.8
Roanoke	91,089	172,037c	1,314	451	...	...	4.9
WASHINGTON							
Bellingham	33,934	629,281	856	466	60	9	13.7
Bremerton	27,746	61,138	754	299	124	31	10.8
Everett	33,807	56,985c	768	237	68	27	7.0
Longview	20,556	37,095	239	78	20	26	3.8
Seattle	462,985	778.249	4 655	1,981	475	235	4.3
Spokane	160,484	629,771c	2,352	1,074	141	146	6.7
Tacoma	142,975	1,062,235	2,808	1,292	168	147	9.1
Vancouver	27,977	105,507c	823	126	53	...	4.5
Walla Walla	24 071	216,516c	386	63	48	19	2.6
Yakima	38,375	140,471	631	329	53	21	8.6
WEST VIRGINIA							
Bluefield	21,341	530.930	208	58	26	17	2.7
Charleston	72,818	227,055	814	328	111	176	4.5
Clarksburg	31,817	627,255	236	98	38	2	3.1
Fairmont	29,273	.....	227	56	48	46	1.9
Huntington	86,160	573.944	1,253	440	138	150	5.1
Morgantown	25,443	183,650c	379	90	42	9	3 5
Parkersburg	29,510	725,463c	388	90	47	12	3.1
Weirton	24,143	46,150	102	66	23	1	2.7
Wheeling	58,447	121,027	802	169	105	39	2.9
WISCONSIN							
Appleton	33,892	129,987	501	279	46	31	8.3
Beloit	29,541	153,071	502	275	109	18	9.3
Eau Claire	35,862	49,934	515	66	50	28	1.8
Fond du Lac	29,826	704,525	714	514	37	28	17.2
Green Bay	52,443	215,591	838	320	75	47	6.1
Janesville	24,829	91,017	503	246	49	...	9.9
Kenosha	54,360	.....	...	...	...	...	..
La Crosse	47,396	138,113	673	461	66	8	9.7
Madison	95,594	188,106d	810	272	113	59	2.9
Manitowoc	27,444	45,614	418	165	35	8	6.1
Milwaukee	632,651	1,994,004	8,872	2,978	724	...	4.8
Oshkosh	40,934	72,051d	456	231	60	11	5.6
Racine	70,749	112,016	1,440	297	67	40	4.2
Sheboygan	42,485	35,906	484	282	85	7	6.7
Superior	35,091	80,363	642	309	48	31	8.8

c. Building and contents. d. Estimated.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
WISCONSIN (Continued)							
Waukesha	21,186	26,403	271	151	24	1	7.2
Wausau	30,386	70,731	510	98	30	12	3.2
Wauwatosa	33 300	36,900	373	115	17	14	3.5
West Allis	42,945	92,470	590	165	44	6	3.8
WYOMING							
Casper	33,557	77,390	317	133	38	26	4.0
Cheyenne	31,807	58,039	339	131	33	11	4.1

1951 FIRE LOSSES, CANADIAN CITIES

ALBERTA							
Calgary	135,000	406,566	959	418	86	172	3.1
Edmonton	158,912	660,021c	996	428	76	139	2.7
Lethbridge	23,000	29,419	161	107	14	13	4.7
BRITISH COLUMBIA							
Burnaby	65,000	.....	...	...	...	...	..
New Westminster	30,000	313,582	434	88	30	20	2.9
Saanich	24,000	37,554	390	133	13	...	5.5
Vancouver	385,500	1,631,186	5,372	1,347	180	111	3.5
Victoria	50,774	223,143d	897	172	23	92	3.4
MANITOBA							
Brandon	21,214	26,104	289	123	5	25	5.8
St. Boniface	26,214	50,381c	326	243	12	26	9.3
Winnipeg	229,045	.....	...	...	...	...	..
NEW BRUNSWICK							
Fredericton	20,000	72,381	860	...	...	47	..
Moncton	30,000	205,618	283	207	14	21	6.9
Saint John	63,000	701,388	1,140	834	32	55	13.2
NOVA SCOTIA							
Glace Bay	28,000	18,958c	97	72	5	2	2.6
Halifax	122,656	357,248	1,349	975	54	113	8.0
Sydney	28,305	534,497	145	...	...	...	..
ONTARIO							
Brantford	36,602	409,393	484	216	49	21	5.9
Chatham	22,000	158,557c	186	121	13	19	5.5
East York Twp.	67,000	23,350c	343	82	35	10	1.2
Etobicoke	46,000	77,176	320	174	31	16	3.8
Fort William	30,585	505,043	581	493	12	18	16.1
Galt	23,085	16,977c	181	95	23	...	4.1
Guelph	25,962	220,461	282	34	5	1	1.3
Hamilton	196,246	460,579a	2,057	703	199	173	3.6
Kingston	36,000	326,635c	561	80	45	68	2.2
Kitchener	43,084	65,647	246	169	25	3	3.9
London	94,027	230,850c	744	202	...	23	2.1
Niagara Falls	20,589	130,145	192	54	31	46	2.6
North York Twp.	62,646	387,461a	656	264	55	16	4.2
Oshawa	40,727	137,191c	363	202	42	26	5.0
Ottawa	220,026	609,957	2,277	1,139	137	112	5.2
Peterboro	35,065	483,436c	567	111	28	...	3.2
Port Arthur	32,000	73,784	441	89	17	25	2.8
St. Catharines	37,988	184,311c	440	175	22	6	4.6
Sarnia	35,000	284,062c	232	135	26	20	3.9

a. Estimated. c. Building and contents. d. Incomplete.

City	Population (Last Census)	Total Loss 1951	No. Alarms 1951	No. Bldg. Fires 1951	No. Auto Fires 1951	No. Malicious False Alarms 1951	Bldg. Fires Per 1000 Population
ONTARIO (Continued)							
Sault Ste. Marie....	33,000	33,250	369	28	16	14	.9
Scarboro Twp.	60,000	198,790	436	124	35	61	2.1
Sudbury	50,222	333,798c	509	115	19	53	2.3
Timmins	26,385	31,297	638	121	21	15	4.6
Toronto	666,467	1,664,085	6,074	2,645	529	644	4.0
Windsor	121,011	280,000a	1,058	461	117	196	3.8
York Twp.	98,000	419,845c	580	129	63	25	1.3
QUEBEC							
Chicoutimi	21,337	.....	...	...	...	...	..
Hull	43,871	551,491	856	...	26	66	..
Jonquiere	25,765	9,146	551	71	12	56	2.8
Lachine	29,625	70,200	78	8	3	27	.3
Montreal	1,181,955	5,766,037	10,718	2,120	473	3,129	1.8
Outremont	32,000	48,030c	218	35	...	...	1.1
Quebec	205,115	854,009	2,823	80	73	621	3.9
Shawinigan Falls ...	38,000	80,000	306	2	...	23	.05
Sherbrooke	52,000	263,624	853	117	40	109	2.3
Three Rivers	53,000	96,027	625	456	16	60	8.6
Verdun	78,000	.....	...	...	...	...	..
Westmount	27,203	71,739c	335	292	...	43	10.7
SASKATCHEWAN							
Moose Jaw	25,000	39,666	344	46	13	38	1.8
Regina	69,995	111,586	667	294	9	105	4.2
Saskatoon	53,000	325,141	557	359	35	57	6.8

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YOUR ASSURANCE OF DEPENDABLE PROTECTION IS THE REMARKABLE YEAR-AFTER-YEAR RECORD OF ADT

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Properties protected by ADT during 1951 experienced a remarkably high immunity from fire and burglary losses. The impressive figures given below are typical of the records established year after year. They furnish convincing proof of the exceptional value of ADT Central Station Electric Protection Services.

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1951

SPRINKLER SUPERVISORY AND WATERFLOW ALARM SERVICE

Supervisory alarms, indicating temporary impairment of sprinkler systems	183,330
Waterflow alarms, caused by fires or serious leaks	3,580
Manual fire alarms	138
Insurable values of properties protected	$9,552,857,000
Ratio of losses to insurable values protected	4/100th of 1%
Fire-loss immunity in 1951	99 96/100%

AVERAGE FIRE-LOSS IMMUNITY DURING THE PAST TEN YEARS 99 97/100%

WATCHMAN'S REPORTING AND MANUAL FIRE ALARM SERVICE

Investigations of failures of watchmen to signal Central Stations on schedule	214,449
Total number of signals recorded	334,615,176
Watchmen's patrol efficiency	99 94/100th%
Alarms from Manual Fire Alarm Boxes	1,393
Insurable values of properties protected	$15,177,188,000
Ratio of fire losses to insurable values protected	8/100ths of 1%
Fire-loss immunity in 1951	99 92/100%

AVERAGE FIRE-LOSS IMMUNITY DURING THE PAST TEN YEARS 99 96/100%

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AMERICAN DISTRICT TELEGRAPH COMPANY
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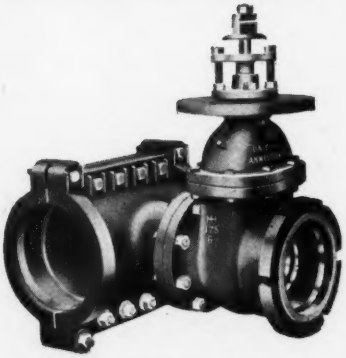
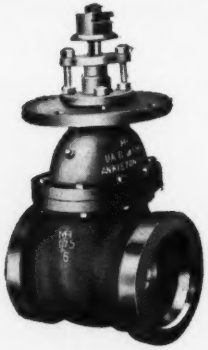
M & H Indicator Post



M & H Tapping Valve and Sleeve



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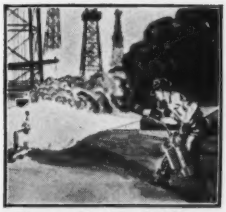
Textile Lint Fires


Flammable Liquid Fires

Gas Fires

Electrical Fires

Ansul Dry Chemical Fire Extinguishing Equipment has world-wide recognition as preferred protection for flammable liquid, gas and electrical hazards. Yet a surprising number of Ansul Extinguishers are used to protect textile mills and paper mills against serious loss from surface fires such as occur in textile lint and combustible paper dust.

ANSUL
MODEL 20-B

The textile and paper making industries rely on Ansul Extinguishers for quick control of dangerous flash fires in class "A" (ordinary combustible) materials. Any remaining embers are quenched with small quantities of water, thereby keeping water damage at a minimum.

Surface fires in textile lint and combustible dusts spread rapidly. They need quick control. If you have serious lint or dust hazards, talk with your Ansul representative. He may have suggestions to reduce fire damage and lost production time.

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Send for File No. 913. You will receive a variety of helpful printed matter. Included is our latest catalog which describes Ansul Extinguishers of all sizes — from the small Ansul Model 4 to Ansul Piped systems and Ansul 2000 lb. Stationary Units.

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250,000-GAL. HORTON STEEL TANK

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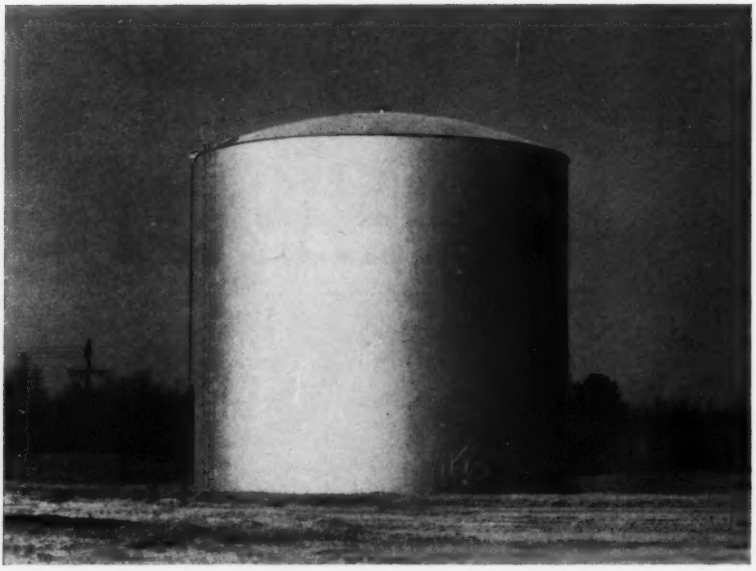

This 250,000-gal. flat-bottom steel tank was installed at the Union Asbestos & Rubber Company's plant in Marshville, N. C., to provide suction for the pumps supplying water for the automatic sprinkler system and wall hydrants throughout the building. The fire protection system is also connected to the Marshville city water mains, giving it two separate sources of water supply.

The Marshville, N. C. plant has a floor area of 40,000 sq. ft. Most of its output of textiles made from asbestos and other fibers is shipped to the company's plants at Cicero and Earlville, Ill., for further processing.

UNARCO, manufacturer of asbestos products, has plants in Paterson, N. J., McGregor, Tex., Marshville, N. C., and Blue Island, Cicero, Earlville and Bloomington, Ill.

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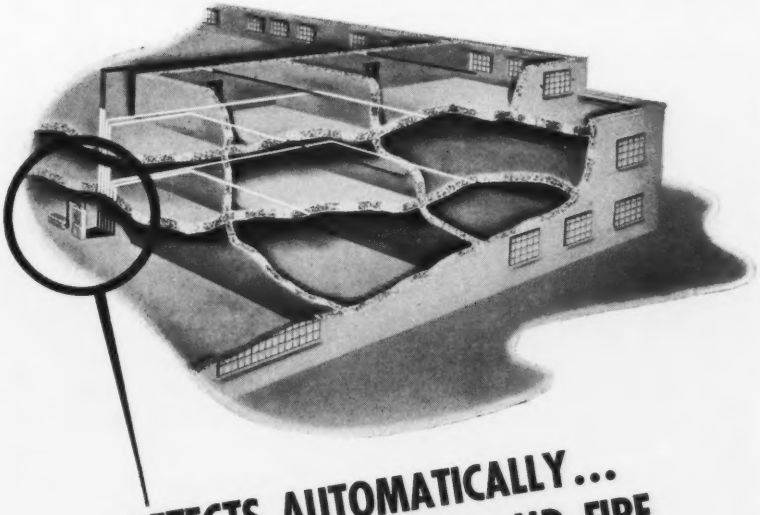
Plants at Chicago, Birmingham, Salt Lake City and Greenville, Pa.



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at any location in your plant or warehouse!

Each fire hazard point gets highly efficient, round-the-clock fire watchman service simultaneously when a building is completely protected with a modern, fully approved C-O-TWO Automatic Smoke Detecting System.

The first whiff of smoke sets off an alarm, based on an exclusive operating principle . . . no chance of smoke, smoldering or fire spreading . . . instantly, the air conditioning shuts down, doors and dampers close, operating equipment stops and fire extinguishing systems actuate . . . a truly automatic fire watchman.

Four types of smoke detectors and several different installation arrangements are available to fit your particular needs . . . single space systems, double space systems, multiple space systems, air conditioning duct systems . . . all function by drawing continuous air samples through simple piping to a smoke detector.

Actual fire tests made by the Underwriters' Laboratories, Inc. show that fire detection with this type of smoke detecting equipment is much quicker than other methods . . . because usually there is smoke or smoldering before flames break out.

Remember fire doesn't wait . . . so, with current expensive delayed replacements, why not let an expert C-O-TWO Fire Protection Engineer help you now in planning economical, fully approved fire protection facilities. Write today for complete free information.

C-O-TWO

C-O-TWO FIRE EQUIPMENT COMPANY

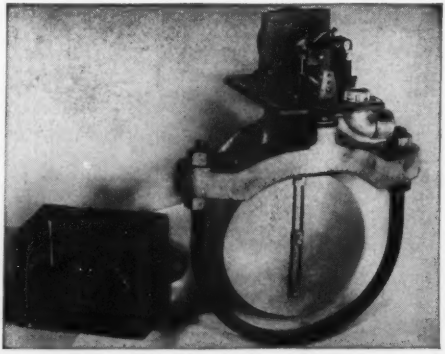
NEWARK 1 • NEW JERSEY

Sales and Service in the Principal Cities of United States and Canada

Affiliated with Pyrene Manufacturing Company

MANUFACTURERS OF APPROVED FIRE PROTECTION EQUIPMENT

Squeez-Grip Carbon Dioxide Type Fire Extinguishers • Dry Chemical Type Fire Extinguishers
Built-In High Pressure and Low Pressure Carbon Dioxide Type Fire Extinguishing Systems
Built-In Smoke and Heat Fire Detecting Systems



5-inch size shown above. To install simply drill hole in pipe.

CENTRAL STATION SIGNALS, INC. Model PRS

Waterflow Alarm Device is approved by both the Factory Mutual Laboratories and Underwriters' Laboratories, Inc. In hundreds of installations it has proved to be the ideal alarm device for sprinkler systems.

SAVE VITAL MATERIALS! Install this water flow alarm device in place of bulky alarm valves. Only 10 oz. of vital material used in our water flow switch.

- **Made in all sizes from 2½" to 8"**
- **It is positive in operation**
- **Has instantly recycling pneumatic retarding device which prevents false alarms**
- **Has enclosed electrical contacts for 15 amp, 125 volts AC and ½ amp, 125 volts DC**

By installing this most economical alarm device, you will know instantly where the water is flowing. Many plants are having them installed on each floor or in each section. They save water damage.

This device can also be obtained as Model PRT, a coded waterflow transmitter from which signals are received on a punch register and single stroke gong. Practically any number can be installed on a two-wire system, thus resulting in considerable savings on wiring.

WE SOLICIT YOUR INQUIRIES

CENTRAL STATION SIGNALS, INC.

Manufacturers of all kinds of approved devices used in Central Station Systems or Class 'A' or Class 'B' Proprietary Fire Alarm Systems, either automatic or manual.

53 WEST 23rd STREET -:- NEW YORK 10, N. Y.

BLOCK THAT FIRE HAZARD WITH

The revolutionary Hooperwood FIRE-CHIEF® process really makes canvas highly fire-resistant. FIRE-CHIEF also makes the canvas resistant to the ravages of water, weather, and mildew. Tensile strength is preserved, and the canvas stays pliable. It lasts *several times* as long as untreated canvas.

FIRE-CHIEF is available in three forms: As finished Hooperwood FIRE-CHIEF Canvas; as protection we apply to the customer's own fabrics; as FIRE-CHIEF Compound to be applied to new or used canvas. Write us today for further information on Hooperwood FIRE-CHIEF Canvas and FIRE-CHIEF processing.

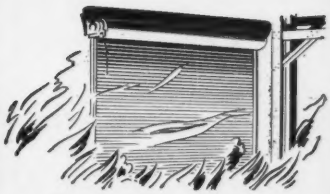
WM. E. HOOPER & SONS CO.

General Sales Offices: **Juniper and Cherry Sts., Philadelphia 7, Pa.**
320 Broadway, New York 7 • 300 W. Adams St., Chicago 6
Hooperwood Mills: **Woodberry, Baltimore 11, Md.**

THEY INSURE PEACE OF MIND

GLOBE
SPRINKLERS
FIREMEN EVERY 10 FEET
STOP THE SURPRISE ATTACK OF FIRE
FIRE never warns you in advance. Don't learn the hard way. FIRE can make a surprise attack when you least expect it. Let us show you how GLOBE Automatic Sprinklers discover and stop FIRE... and lower your insurance costs, too.
GLOBE AUTOMATIC SPRINKLER CO.
NEW YORK... CHICAGO... PHILADELPHIA
Offices in nearly all principal cities
THEY PAY FOR THEMSELVES

"Akbar"—the famous Kinnear Rolling Fire Door



Automatically BLOCKS the Spread of fire

Safety Features Give Building Occupants EXTRA Protection

You get *positive, automatic* fire protection at doorways, windows and other openings with Akbar Fire Doors. They're *pushed* downward by a strong spring . . . *controlled* in downward speed by a special safety device . . . and operable in emergency *after* automatic closure. Coiled out of the way overhead when not in use, they lower quickly into place when fire threatens, cutting off drafts and confining flames to small areas. Approved by Underwriters' Laboratories, they are built in any size. Kinnear Rolling Fire Doors can also be equipped for daily service with motor or manual operation. (Non-labeled Kinnear Rolling Doors are preferred for service use where maximum fire protection is not required.) Write!

The KINNEAR Manufacturing Co.

Factories: 2250-70 Fields Ave., Columbus 16, Ohio; 1742 Yosemite Ave., San Francisco 24, Cal.
Offices and Agents in All Principal Cities

SAVING WAYS in DOORWAYS
KINNEAR ROLLING DOORS

ROLAGRIP

Couplings for plain end pipe

GRUVAGRIP

Couplings for grooved pipe

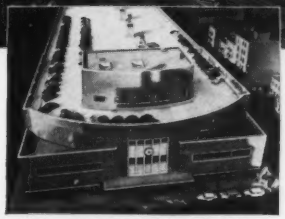
Use Rolagrip couplings on sprinkler systems and you'll enjoy all the time-saving advantages of working with plain end pipe — no threading, grooving, flanging or welding! Or, if the job calls for grooved pipe, Gustin-Bacon offers easy-to-use Gruvagrip couplings.

Both are approved by Factory Mutual Laboratories and listed by Underwriters' Laboratories for use on sprinkler systems. Experience proves real savings where you encounter close work, cut-ins, vibration, water hammers. Both are easy to apply, easy to dismantle, and automatically allow for shock, end pull, vibration, expansion and contraction. Available in sizes ¾" to 12" at your favorite supply store.

GUSTIN-BACON MANUFACTURING CO.

210 W. 10th St., Kansas City, Mo.

Pennsylvania-Duquesne Warehouse, Pittsburgh, Pa. Built by P.R.R. and operated by Pitt-Penn Terminal Co.... the last word in streamlined efficiency and safety. Protected throughout by a Blaw-Knox Dry Pipe Sprinkler System supplying 5,025 Underwriter-approved sprinkler heads.



Midtown Bus Terminal, New York City 9,763 Underwriter-approved sprinkler heads.

American Airlines, Chicago Airport... Blaw-Knox fire protection throughout.

N. Y. Pier No. 42... Norwegian-American Lines protected with 6,726 approved sprinkler heads.

The utmost in protection for your property and goods in transit

While having no insurable interest in consigned merchandise, many transportation companies protect both warehouses and contents with Blaw-Knox Automatic Sprinklers. Insurance companies agree that no other fire protection equals an on-the-spot, fast-acting sprinkler system *engineered* for the hazards involved. Glad to give you a preliminary survey and estimate cost without obligation.

BLAW-KNOX SPRINKLER DIVISION
OF BLAW-KNOX CONSTRUCTION COMPANY
829 Beaver Ave., N.S., Pittsburgh 33, Pa.

BLAW-KNOX
AUTOMATIC
FIRE PROTECTION SYSTEMS

★ 1920 ★ 1952 ★

32 YEARS OF SUPERIOR SERVICE

Prove

CENTRAL AUTOMATIC SPRINKLER SYSTEMS

Your BEST PROTECTION against the fury of FIRE

Whether it be a wet pipe system or a dry pipe system — or perhaps a Central "Electro-Speed" Deluge Sprinkler System, you will find the one BEST TYPE is a CENTRAL SPRINKLER SYSTEM.

They pay for themselves in insurance savings.

Write us for information.

CENTRAL AUTOMATIC SPRINKLER COMPANY

Main Office and Plant
Fourth Street and Cannon Avenue
LANSDALE, PA.
(Representatives in principal cities in United States, Canada and foreign countries)

"Central Sprinklers answer the burning question"

★ 1920 ★ 1952 ★

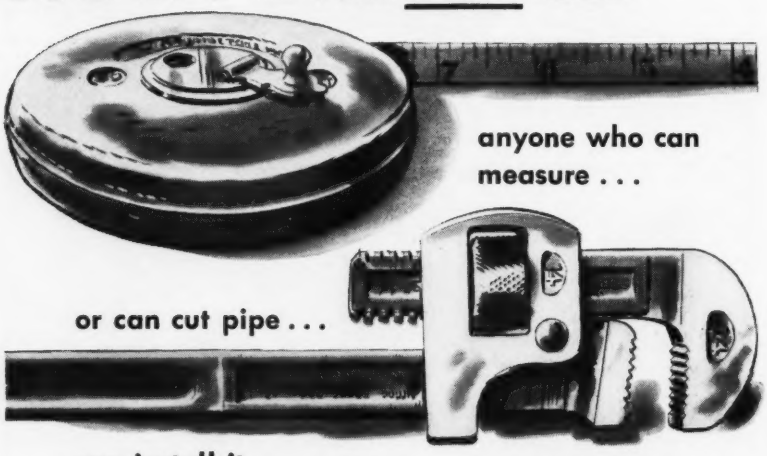
LISTEN CURLEY...
THAT'S ONE EXTINGUISHER
YA' DON'T HAVE TO WORRY
ABOUT GETTING WET!

That's right! Ansul Dry Chemical Fire Extinguishers are Water-tight. Thousands of Ansul Extinguishers stand guard over difficult fire hazards in locations where the extinguisher cannot be protected from the weather.

For installations where extinguishers cannot be pampered with expensive shelters, water-tight construction is essential for dependable fire protection. That's one reason you see so many more Ansul Dry Chemical Fire Extinguishers in outdoor locations protecting all sorts of tough hazards associated with the petroleum industry.

SEE PAGE A5

NEW! NOW! SIX PRE-PACKAGED CO_2 EXTINGUISHING SYSTEMS TO FIT YOUR SPECIFIC NEEDS!



• Here's the answer to inexpensive protection against normal flammable liquid and similar industrial hazards.

The new Kidde Standard Pak is a ready-made, pre-engineered fire extinguishing "package" for any volumes up to 6,000 cubic feet. Each kit contains proven Kidde rate-of-rise heat detectors, multijet nozzles and automatic discharge heads. You can have Paks with or without pipes and fittings. Optional accessories include pressure trips and switches, remote controls, sirens, gongs.

A choice of six sizes assures you of the right package for your special requirements.

K Kidde

The word "Kidde" is the trademark of Walter Kidde & Company, Inc. and its associated companies.

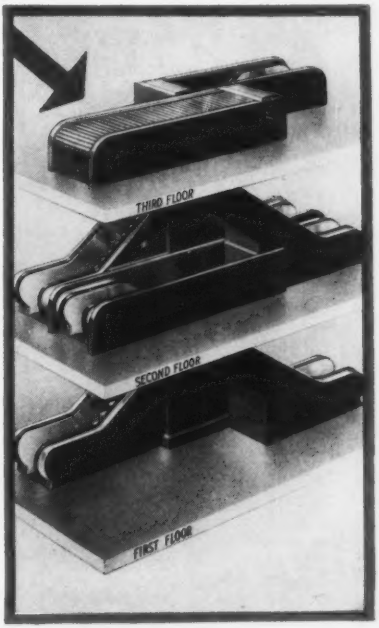
Kidde

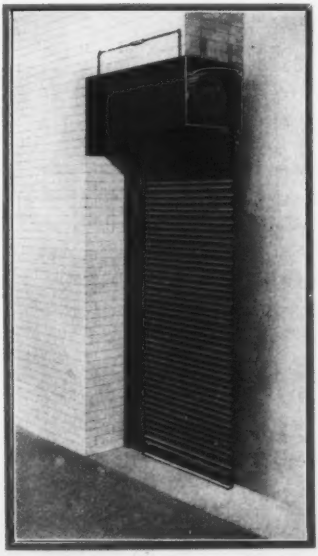
Walter Kidde & Company, Inc.
451 Main Street, Belleville 9, N. J.
Walter Kidde & Company of Canada, Ltd., Montreal, P. Q.

CORNELL
Fireproof
ENCLOSURES
For Moving STAIRWAYS

Created by Cornell in co-operation with elevator manufacturers, architects and safety authorities. Hand crank or automatic motor operation with heat rise and smoke detection control devices. Erection and sales service in any part of the U.S.A.

Fire tested for 3 hours at over 1800°F.





LLENROC
Underwriters
ROLLING STEEL FIRE DOORS

Positive automatic closing upon fusing of exposed link at 160°F. but operate independently of automatic closer in normal use. Fire tested and labeled by Underwriters' Laboratories, approved by Factory Mutual Laboratories, carry 3 hour test label of N. Y. City Board of Standards and Appeals and other state and municipal approval.

Write for "Fire Test Reports" and Catalogs

CORNELL IRON WORKS, Inc. *Since 1828*
36th Avenue and 13th Street · Long Island City 6, N. Y.

Introducing

THE

STAR

Automatic

SPRAY NOZZLE

MODEL FM-C

For More Efficient Extinguishment of Fire in Extra-Hazardous Materials

Designed and approved for better extinguishment in rubber tires and other high-piled storage and in occupancies where special hazards exist. The Star Type FM-C Automatic Spray Nozzle uses water more efficiently and effectively — all discharged water going directly into the fire below. The cooling effect produced by the overlapping discharge of water from the heads prevents combustion at the ceiling. Thus, fewer heads operate and less water is utilized — A MOST IMPORTANT MILESTONE IN THE PROGRESS OF MODERN FIRE PROTECTION!

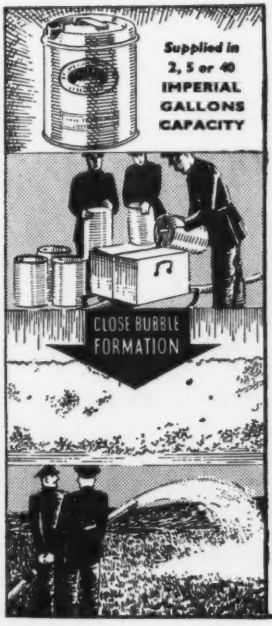
Write us for name and address of the
Star licensed contractor nearest your location

Licensees in all principal cities — and in Canada

STAR SPRINKLER CORP.

Westmoreland and Collins Sts. — Philadelphia 34, Pa.

Kills Oil & Petrol Fires with SPEED & CERTAINTY



★ Nicerol is supplied in heavy gauge steel drums designed for quick release and clean pouring.

★ Nicerol can be used in any type of mechanical foam or air foam apparatus. In this case a base injection type in-line inductor is being operated.

★ The secret of Nicerol effectiveness lies in the small bubble formation. It creates a tough, efficient blanket. 3 gallons of Nicerol and 100 gallons of water will produce over 1,100 Imperial gallons of foam.

★ This petrol and oil blaze (left) was extinguished in a matter of seconds by a normal mix of Nicerol Foam Compound.

Meet the hazard of fire with Nicerol, the foam compound that kills any oil or petrol fire quickly and absolutely. Nicerol is a concentrate, producing a heavy type foam of closely-knit small bubbles which form a tough, vapour-tight blanket over the surface of burning oil or petrol. It is characteristic of Nicerol Foam that it flows with the fire and is highly resistant to flash-back or re-ignition. It can be used successfully in any type of mechanical foam or air-foam apparatus—is equally effective with salt water or fresh and can be stored for years without deterioration.

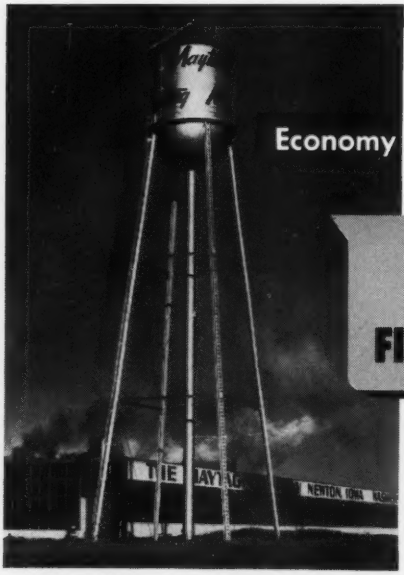
The Royal Navy and the Royal Air Force use it and so do Oil Companies, Fire Equipment Manufacturers, Civil Air Lines, several Commonwealth and Foreign Government departments, and Fire Brigades throughout the world. What better recommendation?

TRADE ENQUIRIES INVITED

For full particulars, samples and catalogues:

NICEROL LIMITED, LISBURN, N. IRELAND

Telephone: Lisburn 2027. *Telegrams: Nicerol, Lisburn.*



Economy in water supply

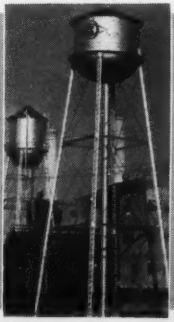
plus
Dependable
FIRE PROTECTION

PITTSBURGH
• DES MOINES

INDUSTRIAL *Elevated Steel Tanks*

Water for process use—for general plant needs—for ever-present sprinkler supply! You're *sure* of dependable water service and protection with storage in a Pittsburgh-Des Moines Tank—your satisfaction is guaranteed by the pioneer builder of elevated steel tanks since 1897. Let us quote on your requirements.

Write today for our complete Elevated Steel Tank Brochure



PITTSBURGH • DES MOINES STEEL CO.

Plants at PITTSBURGH, DES MOINES and SANTA CLARA

Sales Offices at:

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DES MOINES (8). . . . . 969 Tuttle Street
DALLAS (1). . . . 1273 Praetorian Building
SEATTLE . . . . . 576 Lane Street
SANTA CLARA, CAL. . . . 675 Alviso Road

Automatic Rolling Steel
FIRE DOORS *and* WINDOW SHUTTERS PREVENT SPREAD *of* FIRE!

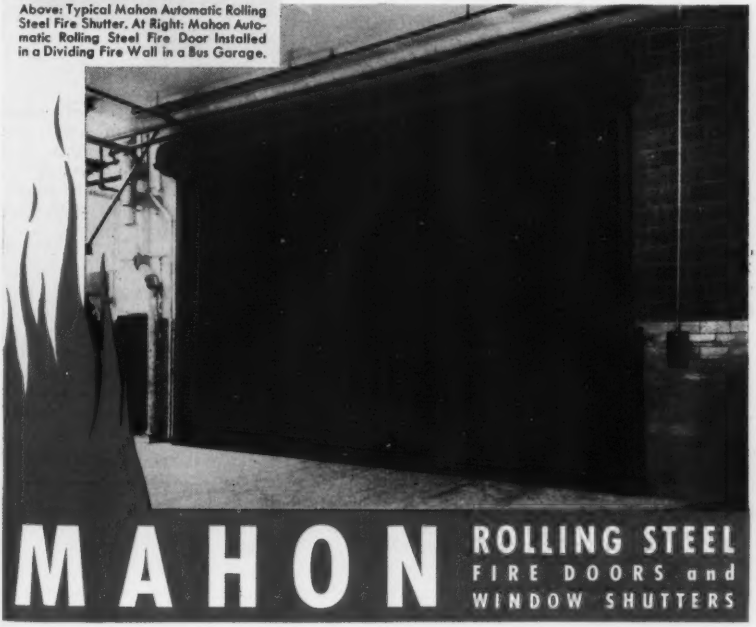
You need good automatic fire doors in fire walls, corridors, and vertical shafts . . . in some cases automatic rolling steel window shutters are necessary to protect your building and its contents from fires which may originate in nearby buildings. Many, many cases are on file which confirm that timely action of automatic rolling steel fire doors and window shutters have confined a fire to its point of origin and permitted its being extinguished with comparatively small damage. Make a survey of your building now, and don't delay action. You will find a Mahon Automatic Rolling Steel Fire Door or Window Shutter to meet each of your requirements—all bear the Underwriters' Label. These automatic fire doors may be operated manually or mechanically in every day use. If a fire should break out while they are in the open position, the automatic mechanism will close the door, cutting off drafts and preventing the spread of the fire. See Sweet's Files for complete information, or ask for Catalog G-52.

THE R. C. MAHON COMPANY

Detroit 34, Michigan • Chicago 4, Illinois

Manufacturers of Automatic Rolling Steel Fire Doors and Window Shutters. Also Many Types of Standard General Service Rolling Steel Doors and Grilles, Insulated Metal Walls, and Steel Deck for Roofs, Floors and Partitions.

Above: Typical Mahon Automatic Rolling Steel Fire Shutter. At Right: Mahon Automatic Rolling Steel Fire Door Installed in a Dividing Fire Wall in a Bus Garage.



MAHON ROLLING STEEL FIRE DOORS and WINDOW SHUTTERS

Sprinkler Protection Revolutionized!

Rockwood T-Head discharging a fixed pattern down into the flame space. Water pattern does not discharge directly onto ceiling. Temperature is cooled to point where ceiling is unharmed.

New Rockwood T-Head Features Greater Extinguishing Power

During extensive field tests in fires of particularly hazardous materials, Rockwood T-Heads have given conclusive evidence of greatly improved sprinkler performance and protection.

PROVED RESULTS

Water patterns from Rockwood T-Heads overlap near ceiling, providing a complete water barrier between ceiling and fire. Water is distributed more effectively, with all discharged water used for cooling. Voids in water pattern are eliminated, preventing hot gases from mushrooming through to ceiling and opening unnecessary heads. *Fires are better controlled with less water and fewer heads.*

APPROVED

by Underwriters' Laboratories, Inc. and Factory Mutual Laboratories, the Rockwood T-Head is designed for use in fixed piping systems. It has a directional wide angle, medium velocity discharge and is installed in a pendent position for automatic or open deluge operation.

Write for illustrated folder

ROCKWOOD

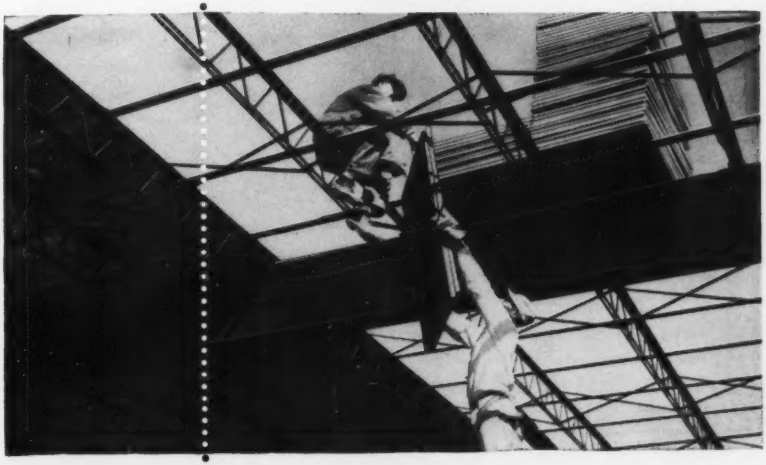
ROCKWOOD SPRINKLER COMPANY

56 HARLOW STREET

Worcester 5, Massachusetts

Rockwood Engineers Water . . . to Cut Fire Losses

Put up Fire-Safe FIBERGLAS Form Board!



Approved where non-combustible roofs are required

BUILDING OFFICIALS CONFERENCE OF AMERICA — BOCA

Report No. 51-6

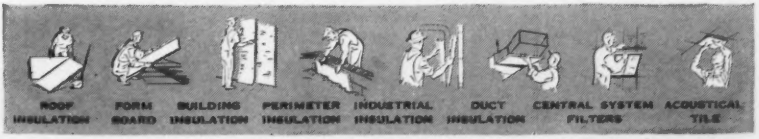
Fiberglas* Form Board is now approved for poured-in-place decks by the Building Officials Conference of America in Report No. 51-6. Look for "BOCA 51-6" on every package of Fiberglas Form Board.

Fiberglas Form Board is dimensionally stable—cannot warp, or buckle, shrink or swell. Resists moisture. Durable. Insulating "k" value of .23. Noise Reduction Coefficient of .75.

For complete details on this outstanding product, contact your nearest Fiberglas Branch Office, or write to: Owens-Corning Fiberglas Corporation, Department 117-D Toledo 1, Ohio.

Four BIG Advantages in ONE Product!

- Form Board
- Roof Insulation
- Acoustical Treatment
- Fire Safety

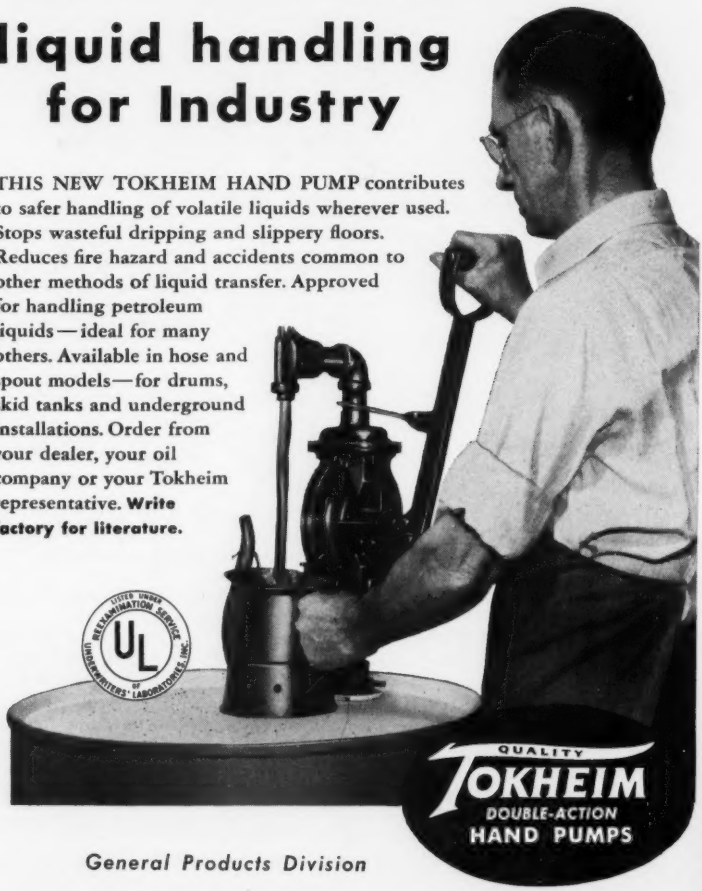


*Fiberglas is the trade-mark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with fibers of glass.

SAFER

liquid handling for Industry

THIS NEW TOKHEIM HAND PUMP contributes to safer handling of volatile liquids wherever used. Stops wasteful dripping and slippery floors. Reduces fire hazard and accidents common to other methods of liquid transfer. Approved for handling petroleum liquids — ideal for many others. Available in hose and spout models — for drums, skid tanks and underground installations. Order from your dealer, your oil company or your Tokheim representative. **Write factory for literature.**



General Products Division

TOKHEIM OIL TANK AND PUMP COMPANY

1686 Wabash Avenue, Fort Wayne 1, Indiana

Factory Branch: 1309 Howard Street, San Francisco 3, California

National Foam Installations Assure Fast, Positive Action

Have you "fire checked" your plant lately? You may now have a greater flammable liquid fire risk than ever before. If gasoline, alcohols, acetone, or mixed polar solvents are stored and used in your plant, complete automatic foam protection should be provided.

Let National Foam engineers study your plant hazards, then recommend "Engineered Foam Fire Protection." If your problem involves technical research, National Foam chemists are well-equipped to develop an answer.

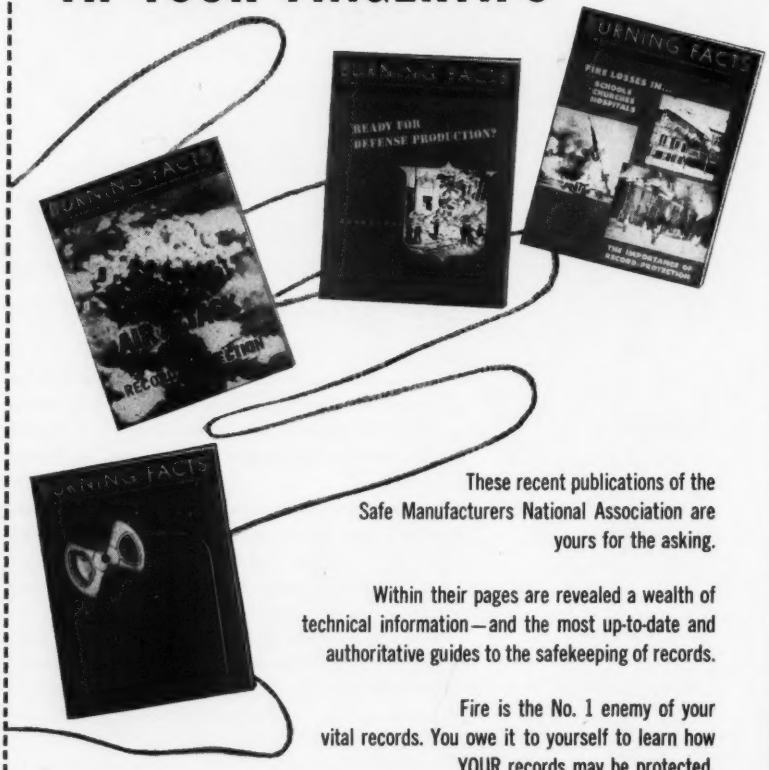
Based upon years of experience in helping leading industries with fire protection problems, National Foam specialists will recommend mechanical or chemical foams, and proper foam making devices to meet your specific requirements.

Consult your nearest National Foam Distributor, or write direct about your problem.

NATIONAL
FOAM SYSTEM, INC.
Headquarters for Foam Fire Protection
WEST CHESTER, PENNA.

NATIONAL FOAM SYSTEM CONTINUOUS FOAM PRODUCTION

A GALLERY OF INFORMATION AT YOUR FINGERTIPS



These recent publications of the Safe Manufacturers National Association are yours for the asking.

Within their pages are revealed a wealth of technical information—and the most up-to-date and authoritative guides to the safekeeping of records.

Fire is the No. 1 enemy of your vital records. You owe it to yourself to learn how YOUR records may be protected.

Write today for one or more of the above titles. They will be forwarded promptly, and without charge, upon receipt of your request on your business letterhead.

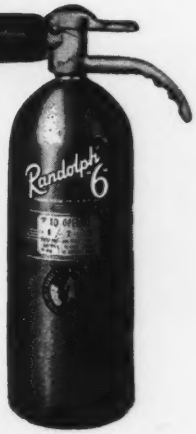
SAFE MANUFACTURERS NATIONAL ASSOCIATION, Inc.
366 MADISON AVE., NEW YORK 17, N. Y.

You know how to operate this extinguisher ... JUST BY LOOKING AT IT!

2½ and 4 lb. Models. Famous "one hand" instant operation.

25 lb. Model. Mobile defense against severe, large-area fires. One man operation.

10 lb. Model. Long-range hose and nozzle, easily portable.



Simple, *obvious* operation makes the Randolph really panic-proof—gets it into action *before* the fire spreads—kills fire instantly with a snowy cloud of CO_2! No valves to turn, no nozzles to adjust; just point and press your thumb! Randolph CO_2 is non-damaging, evaporates without a trace. It's safe, won't conduct electricity, deteriorate or freeze.

UNDERWRITERS' APPROVED — COMPLETE LINE OF EXTINGUISHERS AND SYSTEMS. Learn how Randolph gives your plant better preventative fire protection! Write or wire:

RANDOLPH Laboratories, Inc.,
24 E. Kinzie St., Chicago 11, Ill.

15 lb. Model. Self-balanced extra range and capacity.

Randolph
SIMPLIFIED FIRE EQUIPMENT

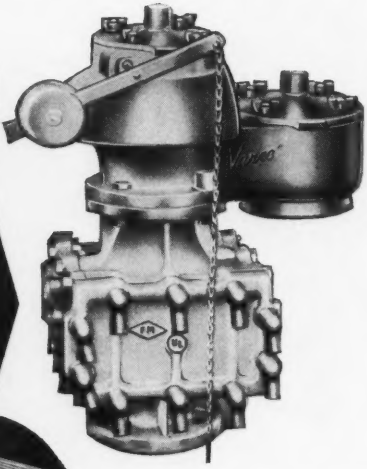
WHEN STORING FLAMMABLE LIQUIDS IT PAYS TO BE

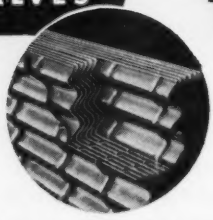
EXTRA **Safe**

with

"Varec" FLAME ARRESTERS

In combination with your **VENT VALVES**





"VAREC" Fig. No. 5800 Vent Unit consisting of "VAREC" Conservation Vent Valve in combination with "VAREC" Flame Arrester.

The belief that conservation vents or breather valves alone will prevent travel of flame back into flammable liquid storage tanks is questionable because of the many contributing factors. Careful authoritative analysis reveals that valves by themselves do provide *some protection* but this "protection" *is by no means adequate* under all circumstances.

Safety authorities emphatically advise that "vent valves are not regarded as providing the required protection against fire and explosion." A textbook on safety states that "a conservative policy is to provide flame arresters in conjunction with other vent equipment on all cone-roof atmospheric tanks handling oils with a flash point up to 200°F open cup."

"VAREC" Flame Arresters when used as a unit with "VAREC" Vent Valves give you full fire protection at extremely low cost. Average installations run approximately .1 of 1% of your investment in tank and products. Consult your nearest "VAREC" representative or write for further information.

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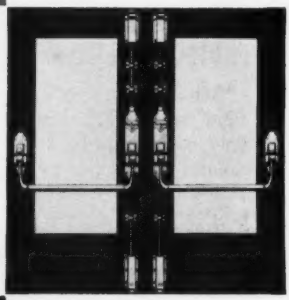

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● Increased production for your plant means more employes, more traffic, more need than ever for safe, dependable exits. Call in your Von Duprin "Exit Specialist" for a free survey of your exit requirements. From actual experience, he can recommend the right Von Duprin exit devices to give you the greatest safety and service. Von Duprin is the most complete line of approved exit devices. From this one line, you can meet *all* your present and potential exit hardware needs. If you don't know the name of your nearest "Exit Specialist," write Von Duprin.

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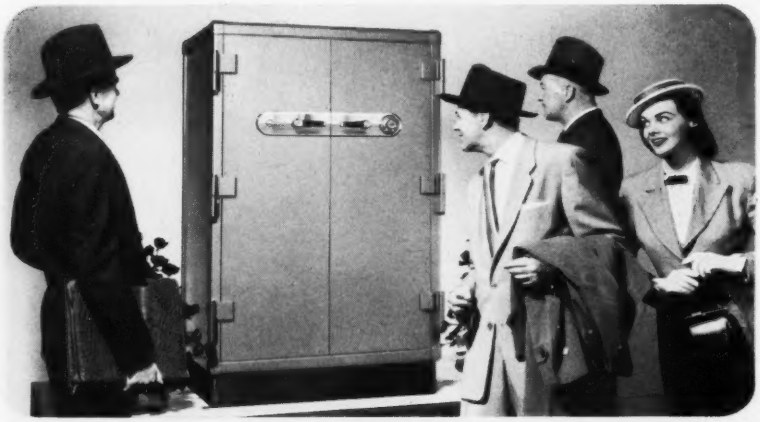

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Because the new Mosler "400" is by far the most important development in record safes in 30 years. Only Mosler engineering and Raymond Loewy's imagination could have made it possible.

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Special construction gives PYRENE Vehicle Type Extinguishers

AT LEAST TWICE THE SERVICE LIFE

OF ORDINARY VAPORIZING LIQUID EXTINGUISHERS

Exclusive!
Vibration dampener protects pump mechanism.
Exclusive!
Tough brass linings guard valve housings.
NO. OF VIBRATIONS
(in millions)
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BRAND A
BRAND B
BRAND C
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In vibrating-machine tests, Pyrene outlasts others up to 15 to 1.

Constant vibration cuts short the life of most vaporizing liquid extinguishers installed on trucks and buses.

Not so with Pyrene* 1 qt. and 1½ qt. Vehicle Type Extinguishers. When subjected to vibration, they'll give at least twice the life of ordinary extinguishers.

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Right: S&J Hydraulic Internal Safety Valve for L.P.G. is available in ¾", 2" and 3" sizes. Can be opened only by S&J operator shown at the left.

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Here at last is a fire door that performs its number one function – restricting the spread of fire–yet is so handsome that it can be used in the finest interior.

The secret lies in the unique construction. The choicest of domestic and imported wood veneers are bonded to an incombustible mineral core.

The Weldwood® Fire Door is approved for Class "B" and "C" openings by Underwriters' Laboratories, Inc., and the Building Officials Conference of America.

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So, before you specify *any* door, be SURE to get full details about Weldwood Fire Doors. *Write today.*

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